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AN ILLUSTRATED REVIEW OF THE INDUSTRIAL APPLICATIONS OF ELECTRICITY, GAS AND POWER.

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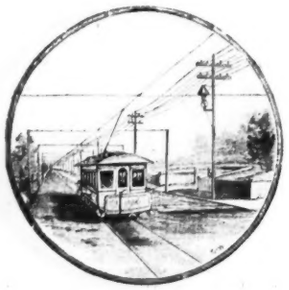

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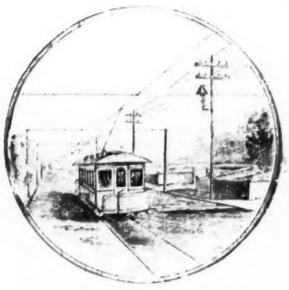

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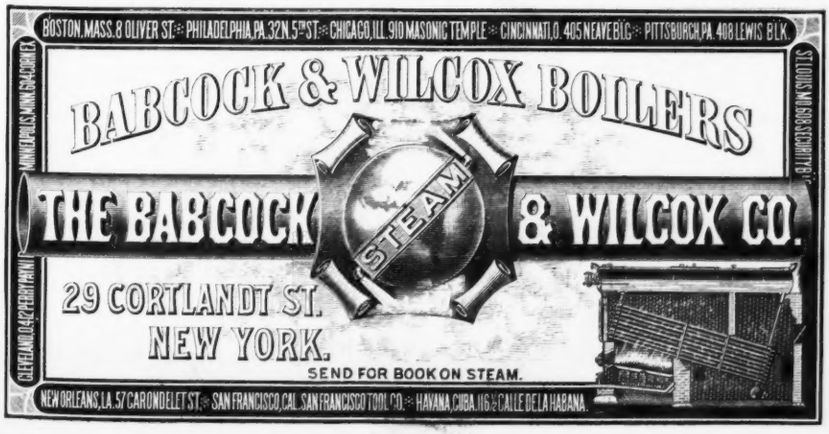
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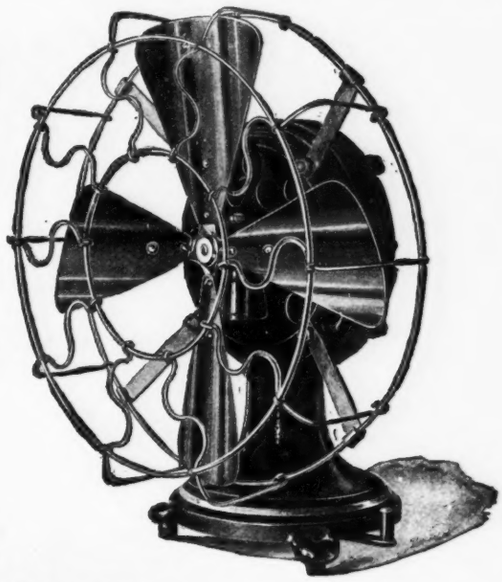

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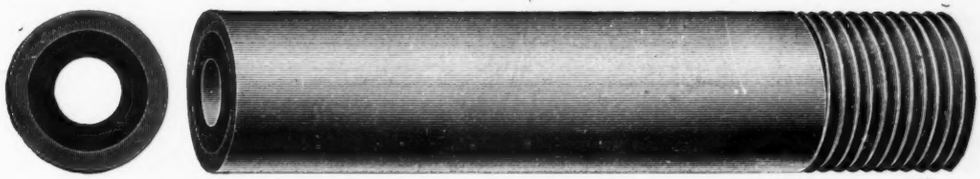

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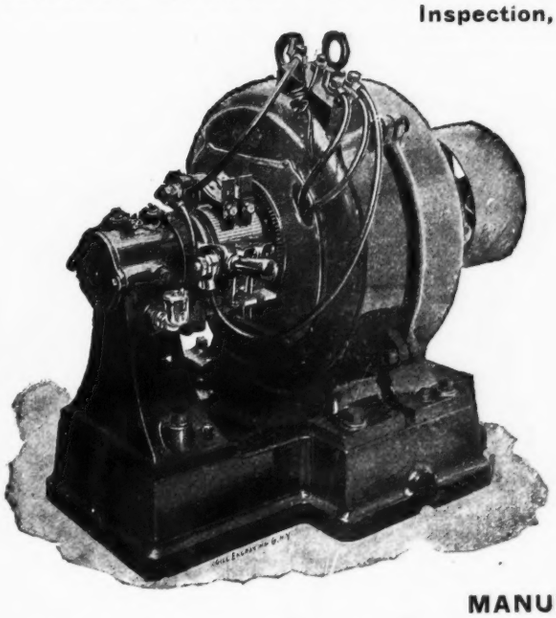

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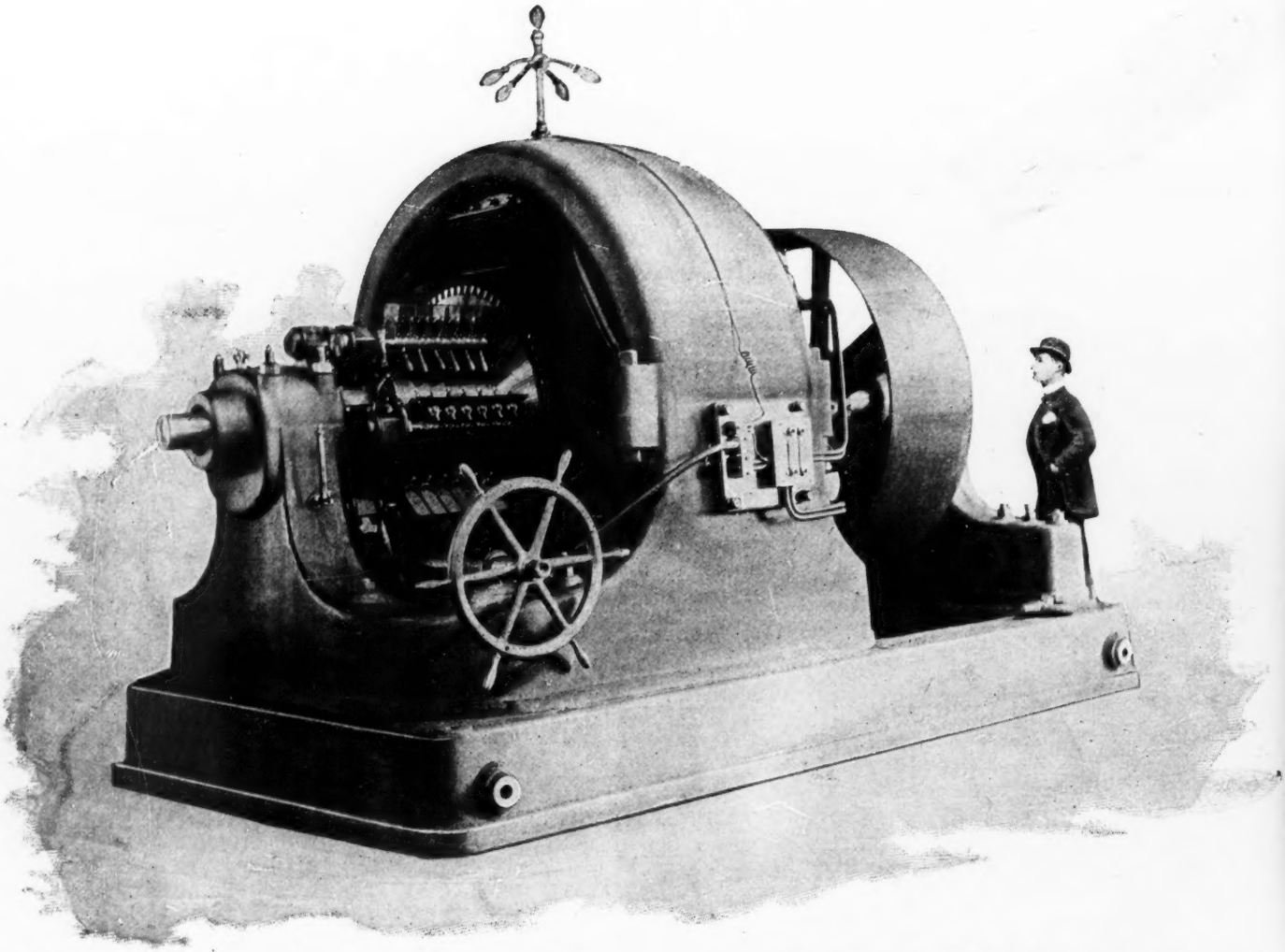

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VOL. I. SEPTEMBER, 1895. NO. 3.

The Folsom-Sacramento Power Transmission.

The utilization of the water-power of the American River was first conceived by the late Horatio Gates Livermore, one of the pioneers of the State, who in the early '60s was engaged in the logging industry. The famous Georgetown Divide, in which the first discovery of gold in California was made, is situated in El Dorado County, between the Middle and the South Forks of the American River. It is a district that is exceedingly mountainous, and is heavily timbered with sugar and yellow pines of unsurpassed quality, and while floating logs down the American River from this district the

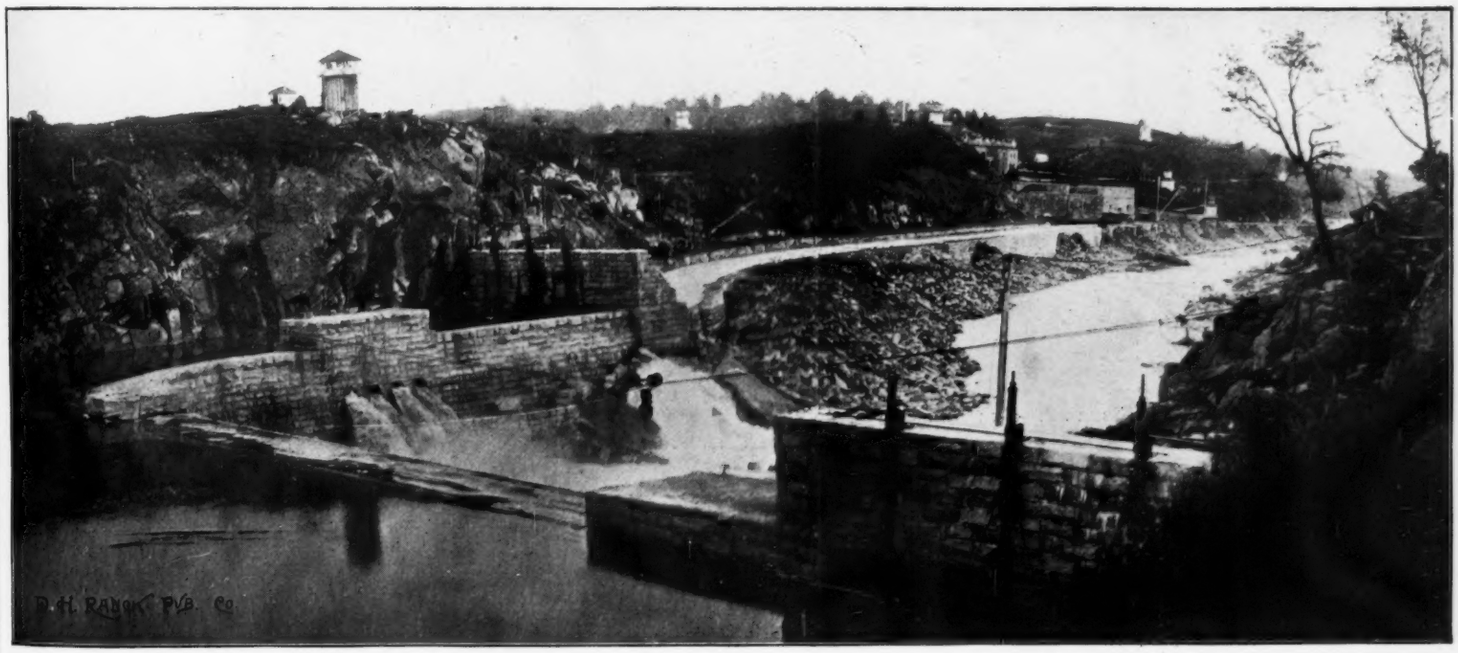

FIGURE 1.—THE DAM AND HEAD WORKS OF THE FOLSOM WATER POWER COMPANY, SHOWING SECTION 1 OF THE EAST CANAL. LOOKING DOWN THE AMERICAN RIVER.

necessity for securing a still water basin for locating log booms to receive the logs became impressed upon the mind of Mr. Livermore, who, in 1866, as President of the Natoma Water and Mining Company, laid the foundations for the present dam. The various forks of the American River rise in the Sierra Nevada Mountains within a few miles of Lake Tahoe, and the supply of the river is peculiar in that the catchment is derived from new sources at all seasons of the year. The period usual elsewhere as the "dry season" is bridged over by the melting of snows in the mountains, and so deep is the snow in some of these regions that the country can be worked or even explored only during a few months in the year. In the fall, when the snows have about disappeared, the rainy season sets in replenishing the waning supply from melted snows, and thus, between the rains of winter and the melting snows of summer, the water supply has never been known to fail. Practically all of the catchment area is, moreover, of granite formation, surfaced with soil of varying depths, and its hundreds of deep ravines form natural sites for the building of impounding reservoirs for increasing the water supply to enormous proportions. In fact, it has been determined from carefully made surveys that an expenditure of less than twenty-five dollars per horse-power in the construction of such impounding reservoirs will permanently increase the flow of the river at Folsom to such an extent that its minimum flow, after these improvements have been carried out, will exceed its present maximum flow. A conservative estimate of the possible power that can be developed by this means at Folsom is a minimum of 15,000 horse-power.

The Folsom Water Power Company, which consists of H. P. and C. E. Livermore, Albert Gallatin, A. J. Ralston, and others, succeeded to all the rights of the

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Natoma Water and Mining Company in 1881, up to which time the foundations of the dam had been laid in solid granite masonry, but so much capital was required to build a dam of sufficient solidity to withstand the enormous pressures, that, in the early part of 1888, a contract was entered into with the State of California, whereby the State in return for ample concessions agreed to furnish to the Folsom Water Power Company such convict labor as was necessary to enlarge and finish the company's dam, and to finish Sections 1 and 2 of the proposed canal to the termination of Section 2 at Robbers' Ravine, near the town of Folsom.

The nature of the site of the dam is clearly indicated in the accompanying illustrations. High granite bluffs confine the river on either side for many miles, and where the dam is erected they form a natural point for the building of such a structure. The dam has an elevation of 210 feet above sea level, and of 175 feet

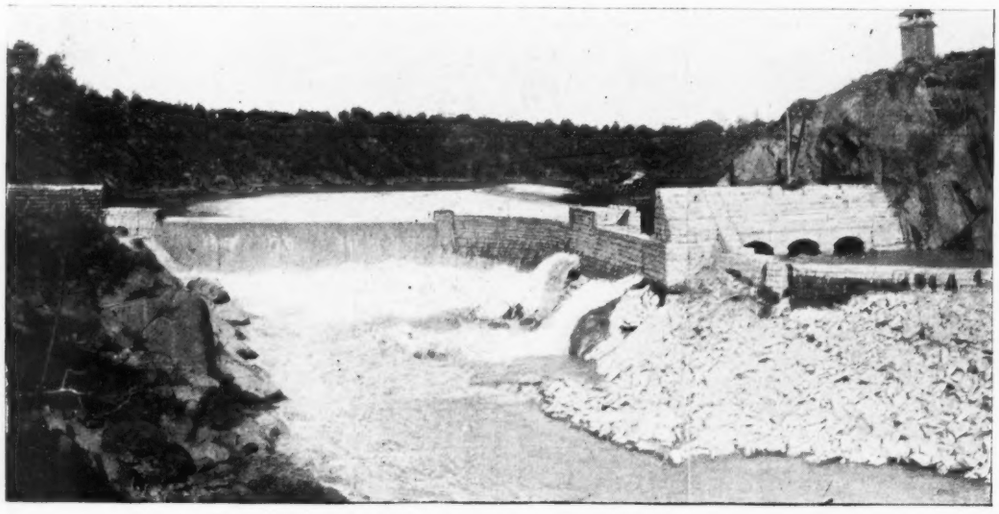


FIGURE 2.—THE DAM AND HEAD GATES OF THE FOLSOM WATER POWER COMPANY, LOOKING UP THE AMERICAN RIVER.

above Sacramento. It contains more than 37,000 cubic yards of masonry, while the contents of the head works is about 15,000 cubic yards. The general dimensions of the dam are shown in Figure 5, from which it will be seen that the crest is provided with a heavy wooden shutter, 180 feet in length, which can be raised during the low-water season in September by five hydraulic rams, so as to create a storage basin for conserving the flow during the hours of light load when the least amount of water is used. The basin formed when the shutter is raised backs up the water in the river for a distance of about four miles, causing an estimated storage of 13,007,105 cubic yards of water. The shutter is a trussed timber platform, resting in a masonry recess running longitudinally along the top of the center of the dam. When raised, the platform is made tight at the ends by wedge pieces, and at the bottom by mud apron boards. When lowered into the recess it is flat and secure from damage by trees and logs which may pass over it. Three of the five hydraulic rams operating the shutter are seven inches in diameter each, the remaining two having a diameter of five and one-half inches each, all having a stroke of five feet six inches each. The details of the larger rams will illustrate the construction of the smaller ones as well. The cylinders are seven and one-half feet in length, with an external diameter of eleven inches, and each has two trunnions on which it is free to oscillate. One of these trunnions is solid, while the other is bored with a half-inch hole to receive the pressure water by which the apparatus is operated. The bottom of the cylinder has a hemispherical cap secured to it by eight, one and one-fourth inch bolts, while at the other end there is a brass stuffing box through which the shank of the piston passes. The piston is six inches in diameter and seven feet eight and one-half inches long, and the piston head is a hemispherical brass knob with a projecting screw, by which it is fastened to the piston. When the shutters have been raised the piston is fastened in position by means of a locking pin, moved back and forth by a pinion and hand wheel.

This hydraulic method of operating the gates is a characteristic feature of the works of the company, and there are in all about thirty similar rams in different places, most of which are operated by hydraulic pressure, at a pressure of 1000 pounds per square inch, piped from the state power house on the canal. Snow and ice are practically unknown at Folsom, and on this account it is possible to use hydraulic apparatus that would prove impracticable in a severe climate. The appliances for operating the head gates on the east side canal, and which are illustrated in Figure 6, are perhaps the most noteworthy of all. The gateways they operate are sixteen feet by fourteen feet in the clear, and are provided with gates opening to a height of twelve feet six inches above the sill, and made of three by twelve inch timbers, secured together by six bolts fastened through them. Each gate is attached by link and pin to the lower end of a piston six inches in diameter, made of wrought iron

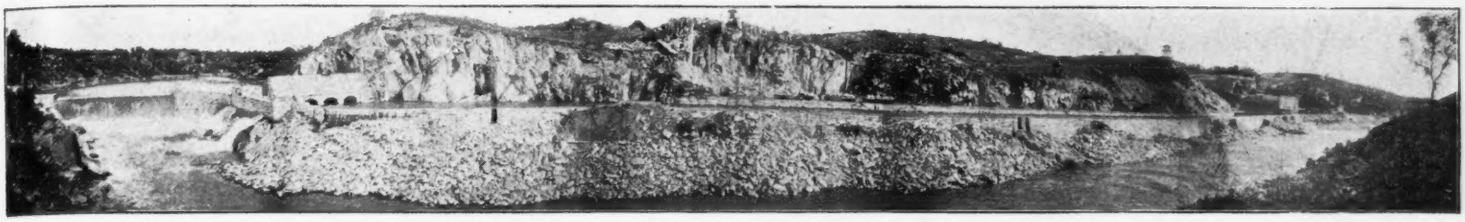


FIGURE 3.—SECTION 1 OF THE EAST CANAL OF THE FOLSOM WATER POWER COMPANY, SHOWING THE STATE POWER HOUSE IN THE DISTANCE.

and sheathed with brass. The brass piston, which is packed with cut leather, moves in a brass-lined cast iron cylinder of twelve-inch bore and thirteen-foot stroke, closed at each end with a stuffing box and gland to receive hemp packing. The pistons are operated by water under the pressure stated, which is delivered to the cylinders through a half-inch pipe. To provide against any movement of the gates by leakage of water in the cylinders, suitable checking gears are placed, there being two such gears to each gate, and these gears are keyed to a three and one-half inch shaft passing through the bracket by which the cylinder is mounted on the bulkhead. A wire rope runs from the top of the gate to each of the wheels, and a spiral spring is riveted at one end to a projecting casting on the gear, and is fastened at the other to a boss on the cylinder bracket.

State is using about 800 horse-power of the power available from this drop. Section 1 is cut much of the way into solid granite cliffs, and the rock taken therefrom was almost entirely used in the construction of the dam and headworks on the east side and in the building of the heavy masonry wall, eight feet wide on the top, from fifteen to thirty feet wide at the base, and in some places as high as thirty feet. This wall, which is built on the bed rock, forms the outer bank of the canal. The section is provided with four sand gates, and is about 2000 feet in length.

Section 2 is constructed with an outside bank of

FIGURE 4.—ROBBERS' RAVINE, MARKING THE DIVISION BETWEEN SECTIONS 2 AND 3 OF THE FOLSOM WATER POWER COMPANY'S CANAL, SHOWING A LOG DAM OF THE AMERICAN LAND AND LUMBER COMPANY AND THE AMERICAN RIVER IN THE BACK GROUND.

THE EAST SIDE CANAL.

Two canals, known as the West Side and East Side Canals, are projected to continue on down the river from the dam. As yet the West Side Canal has not been constructed, but the East Side Canal is entirely finished. It is divided into three sections, the first of which extends from the dam to a point just below the first or State fall, where a drop of 7.33 feet in level occurs, at which is located the State power-house. At present the

earth and rock filling, on which is laid a broad-gauge railroad track, and at the lower end of the section are located four deep outlet gates, raised and lowered by hydraulic rams. Section 2 is 4000 feet long, and its inner side is faced by a heavy masonry wall, and the outer side is protected against the river by heavy rip-rapping.

The third section was built by the Folsom Water Power Company. It is made by earth and rock excavations and an earth rock fill, which forms the outer bank of the canal and which, as in Section 2, carries the railroad track. The outer bank is protected by rip-rap, and some portions of the inside are faced with dry rubble

wall. Section 3 is 3500 feet long, which makes the total length of the canal to be 9,500 feet.

The East Side Canal has a width of sixty-six feet above the headgates. From the headgates to the State fall, Section 1 has a width of fifty-three feet on top and forty-five feet on the bottom. Sections 2 and 3 are each fifty feet wide on the top and forty feet wide on the bottom. They carry water eight feet deep, and with such a grade that the water in the canal has an estimated flow of 104,000 cubic feet per minute.

Four sluice or sand gates, each covering an opening five by six feet through the wing dam, are located at the end of the dam to prevent sand or gravel from passing into the canal and causing injury to the wheels. The bottom of these gates is eight feet below the level of the bottom of the canal, and a short distance further down the stream an eight-foot wall is built directly across the canal. Inasmuch as ordinary gates placed in the side of the canal would only remove the gravel within a few feet of their entrance, three of the gates have a tunnel-like arrangement built through the outer bank, the mouths of these tunnels covering the entire width of the canal. As the entrances to these tunnels are eight feet below the bottom level of the canal, the water is not impeded in its flow thereby, and any heavy substance will be drawn into one or the other of the tunnel-mouths and be discharged through the sluices into the river below.

Between Sections 1 and 2, and immediately over the canal, the State of California has erected the State power-house previously referred to. This is adjoining the yard of the State Prison and is built of heavy granite masonry. It has a floor area of 166 by sixty feet, is sixty feet high, and within it are installed six special eighty-seven-inch Leffel turbine water wheels with vertical shafts, geared through beveled pinions to a horizontal shaft overhead. From this shaft power is delivered by cables and belting to a heavy set of pumps, to a large air compresser, to ice machines and to electric lighting generators. The arrangement at the State fall is such that the flow of water may be directed either to the wheels or turned into Section 2 of the canal through side gates operated by hydraulic rams, and in addition, a log chute or by-pass is provided to facilitate the passing of logs down the canal to the saw mill which it is proposed will be erected at Folsom. No water is wasted at the State fall, but the entire flow continues passing on down the canal.

At the lower end of Section 2 four other sand gates have been placed, but they are more for the purpose of

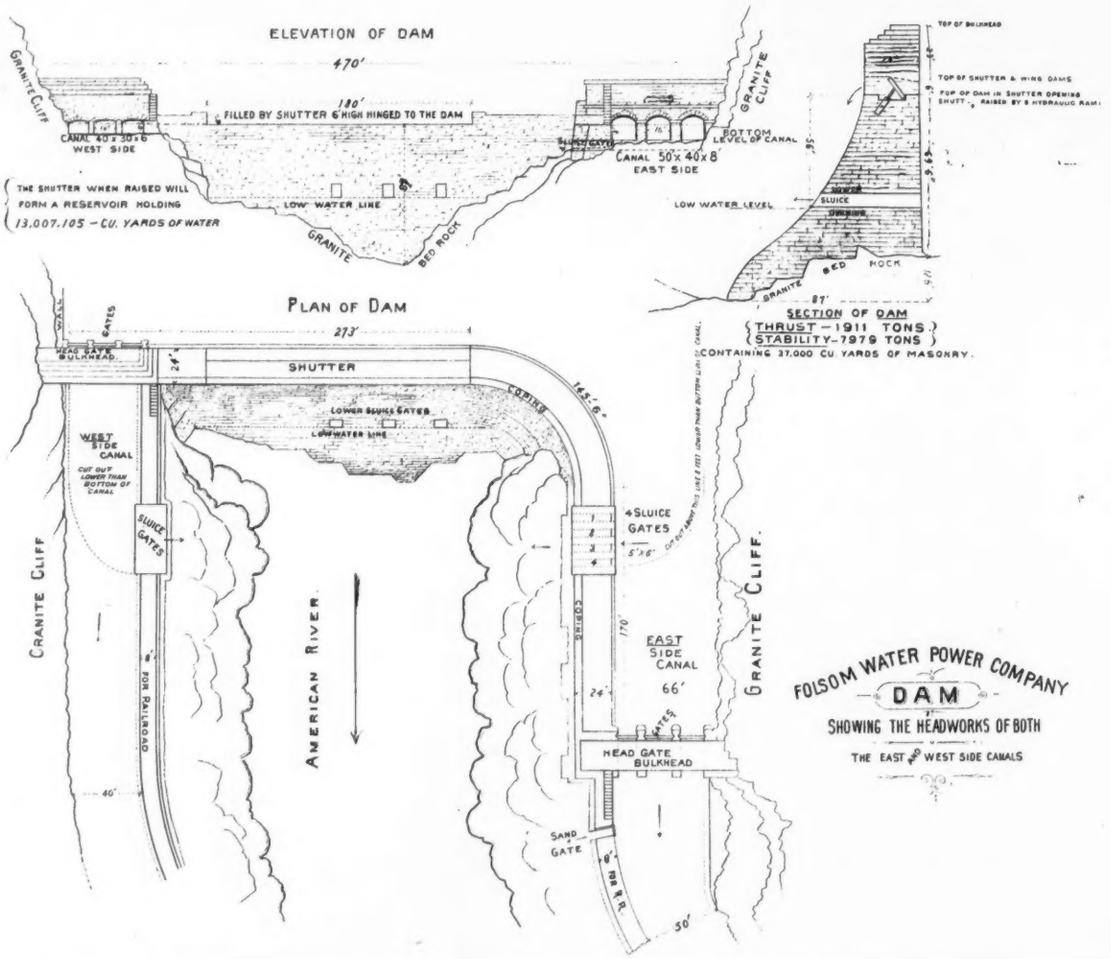


FIGURE 5.—AN OUTLINE PLAN OF THE DAM AND HEAD WORKS OF THE FOLSOM WATER POWER COMPANY.

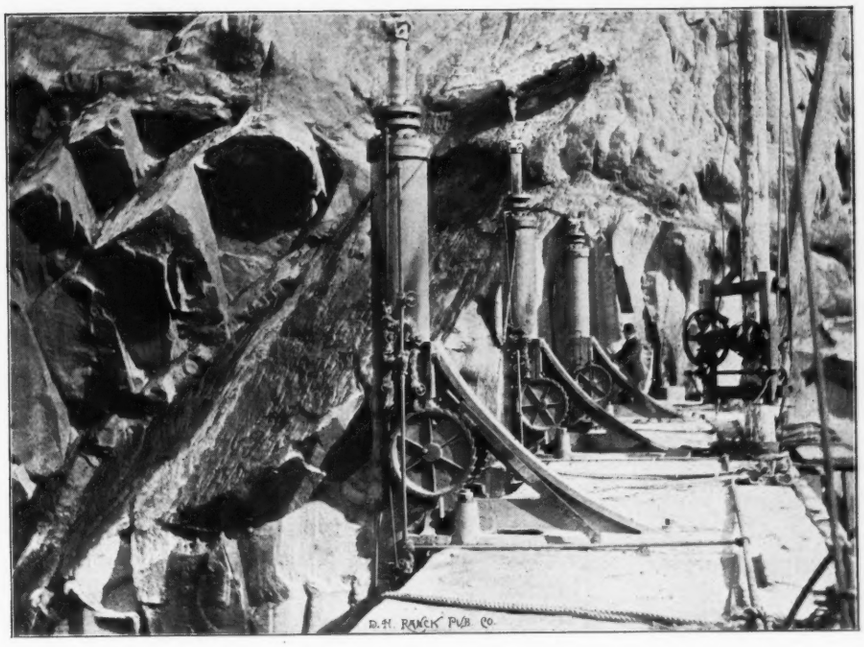


FIGURE 6.—HYDRAULIC RAMS OPERATING HEAD GATES OF THE FOLSOM WATER POWER COMPANY.

relieving the canal during storms than for clearing it of sand deposits. They are not, therefore, fitted with tunnels across the canal. The company's railroad crosses from the outer to the inner bank of the canal on a substantial truss bridge, supported by heavy masonry buttresses at the upper end of Section 3. Just below this bridge a timber boom is extended across the canal to deflect the logs into a large log basin covering several acres.

THE HYDRAULIC PLANT.

The dam and canal is the property of the Folsom Water Power Company, but the plant about to be described is the property of the Sacramento Electric Power and Light Company, which has acquired all the power rights for the water from the Folsom Water Power Company. At the terminal of the canal a forebay, 150 feet long, 100 feet wide and twelve feet deep has been constructed in a northwesterly direction at right angles to the canal. It is divided lengthwise by a continuous stone wall, reaching above the top of the water and extending from the canal to the power-house, so as to make virtually two forebays. Each of these is again divided longitudinally by planking which does not reach to the surface of the water, and gates are placed at each end of each forebay.

This construction was carried out because at certain seasons of the year much silt is held in suspension in the water of the American River, owing to the hydraulic mining constantly going on in its upper branches. The velocity of flow in the river and canal is sufficient to carry this silt along, and unless it were interrupted it would cause considerable trouble in the turbines. Advantage has therefore been taken of the fact that when a channel is widened out so as to cause slack water silt will be deposited, hence wide forebays were constructed. It will now be clear that in order to clean out the silt it will only be necessary to check the flow in one of the divisions of the forebay by closing the wheel gates and opening the waste gates, thus allowing a small flow to take place in the forebay, dropping out all silt with it. Then the water is again let in, and the wheels may be started and the other part of the forebay may be cleaned out.

But one forebay was completed up to the time of the Electric Carnival, hence the plant was operating to only half its capacity, but by October 1st the remaining forebay will be entirely finished, when the entire plant will be practically completed. The hydraulic part of the equipment was furnished by the S. Morgan-Smith Iron Works, of York, Pa., under contract with the Pelton Water Wheel Company, of San Francisco, and consists of four pairs of 30-inch McCormick turbines, having a capacity of 1260 horse-power each, and two of which, together with an exciter turbine, are illustrated in Figure 7.

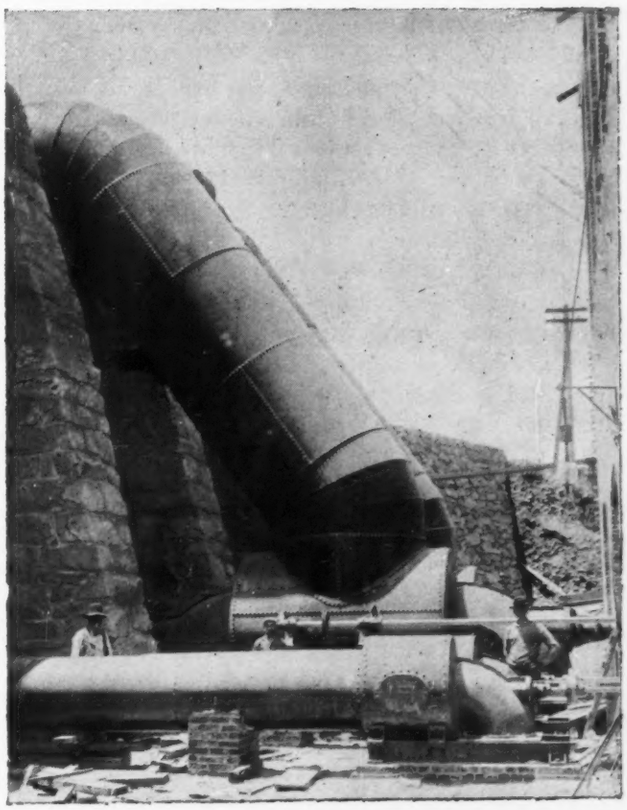


FIGURE 7.—PENSTOCKS AND TURBINES FOR TWO UNITS IN THE POWER HOUSE OF THE SACRAMENTO ELECTRIC POWER AND LIGHT COMPANY.

The wheels run under a head of fifty-five feet at 300 revolutions per minute, and are directly connected to the armature shafts of the generators by insulated couplings. The inlet pipes are eight feet in diameter, and made of five-eighths-inch steel, with double draft tubes.

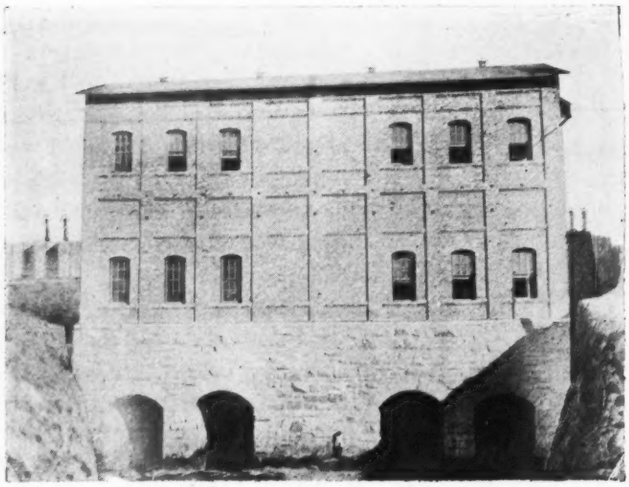


FIGURE 8.—THE POWER HOUSE OF THE SACRAMENTO ELECTRIC POWER AND LIGHT COMPANY AT FOLSOM.

Each pair of wheels is furnished with a steel flywheel ten feet in diameter, weighing 10,000 pounds, and which has a peripheral speed of 9425 feet per minute. To provide for the centrifugal strain that such a high velocity gives, heavy steel tires are shrunk on to the rims. The exciters are run by two special wheels of a size to give them the proper speed, which are also direct connected as in the case of the larger wheels. The governors are of the Feasch-Picard type, the same as are used on the Niagara wheels, and, being located in the generator room, are convenient for observation and control. Under the present temporary conditions it is necessary for an attendant to watch the tachometer and control the water manually.

The wheels are made of phosphor-bronze and the work throughout embraces the latest and most improved practice in hydraulics. The hydraulic equipment weighs upward of 400,000 pounds, and the plant, as a whole, is believed to be the most massive and powerful in the world, with the single exception of that at Niagara.

THE POWER HOUSE.

Coupled direct to each of these four turbines, as stated, through a 6 7-16 inch shaft fitted with insulating flanges, is a 750 kilowatt three-phase General Electric generator. At the time of the Electric Carnival only two of these generators, as shown in Fig. 10, were in operation, and these are without doubt the largest three-phase dynamos yet constructed. Their height is 8 feet 8½ inches, they cover a floor area of 11 feet by 8 feet 8 inches, and their weight is 57,877 pounds each. They are provided with twenty-four poles, and deliver a three phase current at a periodicity of sixty cycles per second and at a potential of 800 volts. The station is provided with two four-pole 500-volt exciters, having a capacity of 30 kilowatts each, and the entire four generators may be excited from either exciter.

From the generators the current is led through the simple switching-board, Fig. 10, to the bank of the step-up transformers placed in the transformer chamber on the upper floor of the building. These are of the large air-blast type manufactured by the General Electric Company, and each have a capacity of 265 kilowatts. Each generator feeds a group of three such transformers, making a total rated transformer capacity of 3180 kilowatts in the power house.

Only the dynamo potentials are handled at the station switchboard, which is, as stated, essentially a switching board. The two outside panels control the four generators, and as the board is provided with double sets of bus bars, the generators may be coupled to the circuits of the pole lines as desired. The center panel contains the synchronizing indicator lamps, the exciter instruments and the main line switches, while the generator panels, in addition to the switches, are provided with a voltmeter, current indicator, and the usual pressure regulator in each set. The switchboard is of Tennessee marble, and presents a very handsome appearance.

Both the primary and secondary coils of all step-up transformers are worked in parallel, taking current at 800 volts from the generators and delivering to the lines at a potential of 11,000 volts. Each generator is provided with a separate and distinct circuit from the power house to Sacramento, and they may be worked singly or in parallel, in the latter instance a synchronism being effected through the use of suitable indicators. As yet the transformers are run without the air blast, but as soon as the load increases sufficiently to cause material heating, both the power house at Folsom and the sub-station at Sacramento will be equipped with Sturtevant blowers, each operated by a 2-kilowatt inductor motor.

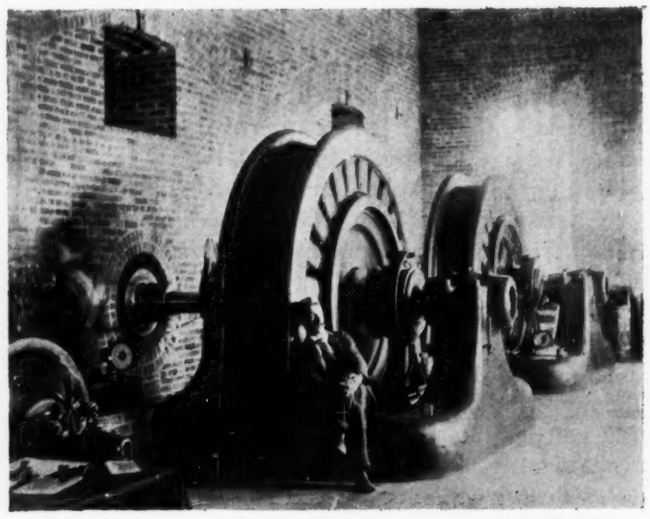


FIGURE 9.—TWO OF THE FOUR 750-KILOWATT THREE-PHASE GENERATORS IN THE FOLSOM POWER HOUSE.

The power house, which is shown at Fig. 8, is divided into practically four parts. The photograph from which the accompanying illustration was made was taken before water was run into the tail-race, and at present the water comes up within a few inches of the

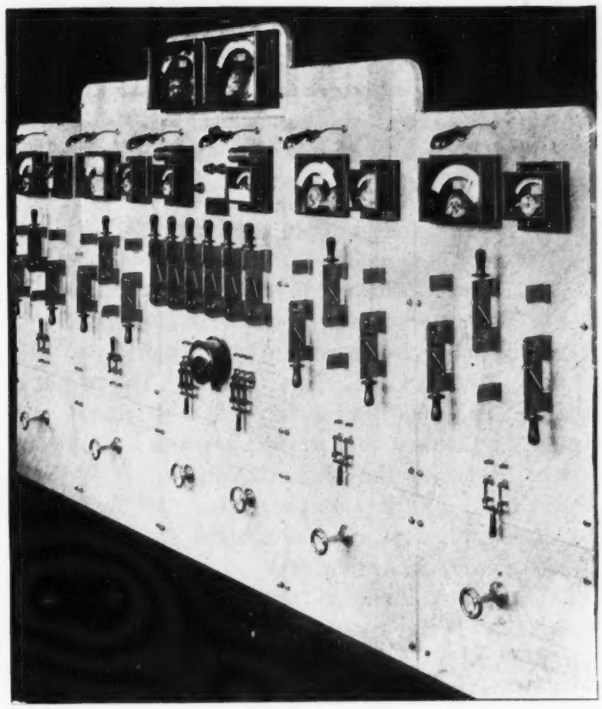


FIGURE 10.—GENERATOR SWITCHBOARD AT THE FOLSOM POWER HOUSE.

arches. The tail-race forms the first section of the power house and the first story is divided into two portions, one for the turbines and the other for the electrical apparatus. The transformers occupy the upper story, forming the fourth portion of the station. The secondaries are led from the transformers to the pole lines out through twelve porcelain-lined holes in the end of the station, protected by a substantial hood.

THE POLE LINE.

The pole line fittingly exhibits the care that has been exercised in the construction of the entire installation. It is a double line throughout, and following, as it does, along the sides of the country road and the Sacramento Valley railroad, it forms an avenue of poles 20.4 miles in length and of uniform construction. Forty-foot peeled Washington cedar poles of diameters averaging twelve inches at the top to sixteen inches at the butt, are used throughout the country division, but in the city sixty-foot poles have been placed at points of intersection with other pole lines. The transmission circuits proper, or those carried on the country pole lines, are supported on large special double-petticoat porcelain insulators that have been tested to withstand a potential of 25,000 volts A. C. The pole lines each support six No. 1 B. & S. bare copper wires, effecting transmission with an estimated line loss of ten per cent. Four such wires are carried by the upper cross arm and the two remaining wires by the remaining cross arms, as clearly shown in Figure 11. The illustration also shows that the poles are gained for two extra cross arms, with the intention of doubling the capacity when necessary. The cross arms, which are braced with angle irons, are seven feet in length, having a section of 4 x 4 inches, and the poles are set fifty to the mile, being placed six feet in the ground.

For many years the Sunset Telephone and Telegraph Company operated a long-distance telephone line between Sacramento and Folsom. It was of ordinary galvanized iron construction and grounded at each end, but as soon as the power transmission lines were put in operation the telephone circuit became useless from the induction. The new Capital Telephone and Telegraph Company, however, which has just been established in Sacramento, secured the privilege of placing a third cross arm on one of the pole lines a distance of thirty-six inches below the lowest power line. Number 14 bare copper wire is supported on porcelain knobs four feet apart, and the wires are transposed at every fifth pole. Columbia receivers and carbon transmitters are used, and the service is not only satisfactory between Sacramento and Folsom, but conversation may be carried on from Sacramento to Placerville, which is thirty-eight miles beyond Folsom, or a total distance of fifty miles.

The actual length of the power transmission circuits as measured by the pole line is as follows:

	Feet.
From the power house to the railroad depot at Folsom	1,056
From the Folsom depot to the limits of Sacramento	102,432
From the city limits to the sub-station	10,000
Total length of pole line	113,488

Or, practically, 21½ miles.

FIGURE 11.—DOUBLE POLE LINE TRANSMISSION CIRCUITS OF THE SACRAMENTO ELECTRIC POWER AND LIGHT COMPANY.

THE SUB-STATION.

The distributing station, as the step-down or sub-station of the Sacramento Electric Power and Light Company is called, is located on the northwest corner of Sixth and H streets, Sacramento, quite close

to the business portion of town. It is a substantial fire-proof structure, two stories in height, with an airy basement, and in addition to the general offices of the company, which, when completed, will occupy the front

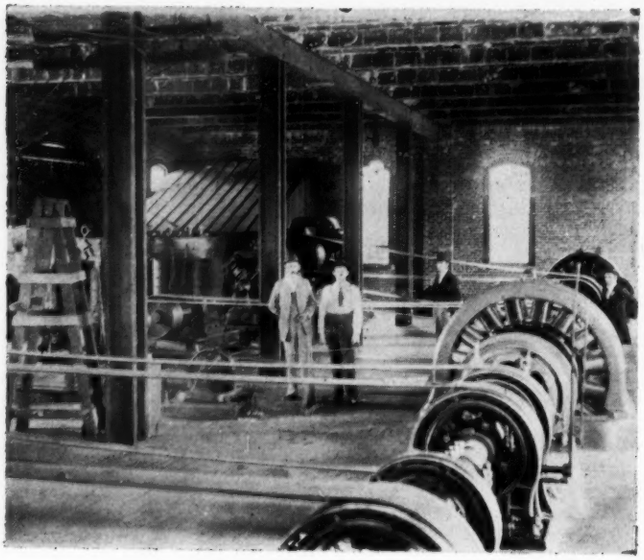


FIGURE 12.—THE MOTOR-GENERATOR ROOM IN THE SUB-STATION OF THE SACRAMENTO ELECTRIC POWER AND LIGHT COMPANY AT SACRAMENTO.

corner portion, it contains the motor and generator room (Fig. 12) on the ground floor. This room has an area of 50 by 100 feet in the clear, and here are located the three 3-phase synchronous motors and the various electric railway generators, and arc lighting dynamos comprising the plant.

From the pole line the transmission circuits are led direct to the step-down transformer chamber in the sub-station. Only a temporary wooden apartment, which appears in the corner of the dynamo room (Fig. 12) is used at present, as the permanent chamber has not yet been completed. Here are located nine 125-kilowatt type "A B" or air blast transformers, taking energy at 10,000 volts, and transforming down to the various potentials required for the different forms of distribution.

The large 250-kilowatt synchronous motors are supplied with energy from six of the nine 125-kilowatt transformers, delivering current at 500 volts. The remaining transformers step down to 125 volts, the current being distributed over the city on a four-wire system consisting of three wires for the three-phase current, and of a fourth or neutral wire. The incandescent lighting service is rendered from extensions made between either of the three wires and the neutral, due care of course being maintained to keep the circuits balanced within reasonable limits, but the power service is rendered from the three-phase wiring without reference to the neutral in any way. Motors of large capacity will undoubtedly be operated from 500-volt three-phase wiring, while the 125 and 250-volt four-wire system will be used for incandescent lighting and small motor work.

The synchronous motors used are of the General Electric "A F" type, form A, and each have a capacity of 250 kilowatts. These motors are identical in all details. Each has sixteen poles, and develops 300 horsepower at a speed of 450 revolutions per minute. They are operated at an E. M. F. of 500 volts, the current alternating at a periodicity of 60 cycles. A peculiarity of the plant is the fact that the motors are connected directly in line with the main shafting through friction clutches, and all pulleys on the shafting are friction pulleys. The main shafting, including the motor shafts, is 91 feet 6 inches in length over all, and has a uniform diameter of seven inches. Its speed is, of course, identical with that of the motors, or 450 revolutions per minute, and from the shaft are belted direct: One General Electric, 4-pole, 200-kilowatt, 500-volt railway generator; two Edison bi-polar, 500-volt railway generators rated at 100 kilowatts each, and one Thomson-Houston M. P. 90,

FIGURE 13.—THE CAR BARN OF THE CENTRAL ELECTRIC RAILWAY COMPANY, SACRAMENTO.

500-volt generator; also three Brush arc lighting Class Y dynamos, each having a capacity of 100, 2000 candle-power arc lamps, and each of which, therefore, has a rated output of 9.6 amperes at 5000 volts. The approxi-

mate energy required to operate these dynamos at full load is 1000 horse-power.

No novel features are presented in the switchboards, which are of the usual fire-proof form. The sub-station will eventually contain four distinct boards, the first of which handles the incandescent lighting circuits of the city. From the second switchboard, which is fed with 3-phase current at a potential of 500 volts from the transformer room, the circuits run through the usual devices to the three 250-kilowatt motors described. The third switchboard will control the various railway generators and circuits, while the fourth switchboard is the standard form of arc lighting board designed and manufactured by the General Electric Company.

POWER CONSUMPTION.

An observation that should be emphasized in a description of the Sacramento Electric Power and Light Company's plant is the fact that a market for a considerable portion of its output is already contracted for. The transmission scheme itself is, therefore, a reality and not a venture, and of its consumers at the present time, the Central Electric Railway Company, comprising the entire street railway system of the city, is the largest patron. This road embraces 24.5 miles of a single track and 17 miles of double track, a standard gauge of 4 feet 8½ inches being used. The rails are of combination type, weighing from 35 pounds to 56 pounds per yard, according to whether they are used on the main thoroughfares or on branch lines. The cars are largely of the combination type, and the practice of equipping each car with a 15 horse-power single reduction motor has been adopted because Sacramento is an absolutely level city, and the simple single equipment has been found to be satisfactory in every way. Brill trucks are used exclusively, and in all the system comprises thirty-two motor cars and three trailers. The maximum power required to operate the system is 650 horse-power, but in laying out the station a surplus of 250 horse-power has been provided for extensions of the road, and the capacity available by the railway company from the transmission circuits, is, therefore, 900 horse-power.

The Company owns about three-quarters of the block bounded by Twenty-eighth, Twenty-ninth, N and M streets, upon the south-east corner of which is located the large brick car-barn illustrated in Fig. 14. This structure has a capacity of housing forty-eight cars, and in addition contains in the rear a well-fitted repair shop operated by electric power. Other buildings adjacent contain a blacksmith, carpenter and paint shop, while the offices of the general manager of the road occupy the front corner portion of the main building.

The system is well provided with features for attracting the patronage of the amusement-loving public. At East Park, on Thirty-first street, the company has erected the largest toboggan slide in the State, which is operated by a 10 horse-power electric motor run from the railroad circuit. Here a hotel has been erected, and the park itself is a very attractive recreation and picnic ground. Oak Park, which is owned by the company, is situated on the south-east corner of the city limits, and here are found lawns, gardens and other attractions, among which is an excellent dancing pavilion. The branch of the railroad reaching Oak Park also extends to the baseball ground, while on the M street line is located the well-known Sutter's Fort with its surrounding grounds, and which daily attracts hundreds of visitors.

New demands for power seem to be arising daily and negotiations are now in progress with the Southern Pacific Company for the placing of 900 horse power in motors in the railroad shops, which at present are operated by steam. These shops employ about 4000 men, and it is possible that the amount of power required for their operation may materially exceed the figure named.

Sacramento is located on a low, level country that is protected from inundations from the Sacramento river by means of levees built along its bank, as a result of which there is a considerable seepage of water beneath its soil, and at present this seepage is collected by means of percolation, and pumped back into the river, the power for running the pump being obtained from the city water-works. During the recent State Fair, however, the members of the City Board of Trustees were so impressed with the efficacy of operating centrifugal pumps from induction motors that they have now passed a resolution inviting proposals for the operating of the city pumping station by electricity, and as a result of which, it is believed that the Sacramento Electric Power and Light Company will receive the contract for delivering several hundred horse-power for the purposes named.

Referring to the question which has been raised from time to time as to the water-power available for use at Folsom, Mr. H. T. Knight, consulting hydraulic engineer for the Folsom Water Power Company and who has perhaps made more careful measurement of the water supply of the American River than any other person, reports that the available fall below the power-house from the tail race of the plant to the American River is twenty-six feet, while the head utilized by the present plant is 55 feet. This twenty-six-foot fall can be readily utilized, Mr. Knight states, by constructing about 100 feet of canal from the present tail race, fifty-five or sixty feet in length, to carry the water from the proposed supplementary power-house to the river. The present arrangements of the Sacramento Electric Power and Light Company contemplate the use of only about one-third of the capacity of the canal, and its remaining capacity may be made available for additional installations by a comparatively small outlay.

The electrical equipment of the system of the Sacramento Electric Power and Light Company was installed by the General Electric Company through its regular engineering corps, the work being placed under the general supervision of Mr. J. A. Lighthipe, Chief Engineer of the Pacific Coast office, who was assisted by Mr. A. C. Jewett, Superintendent of Construction at the power house, by Mr. B. O. Boswell, Superintendent of Pole Line Construction, and by Mr. C. O. Schaeffer, Superintendent of Construction at the sub-station.

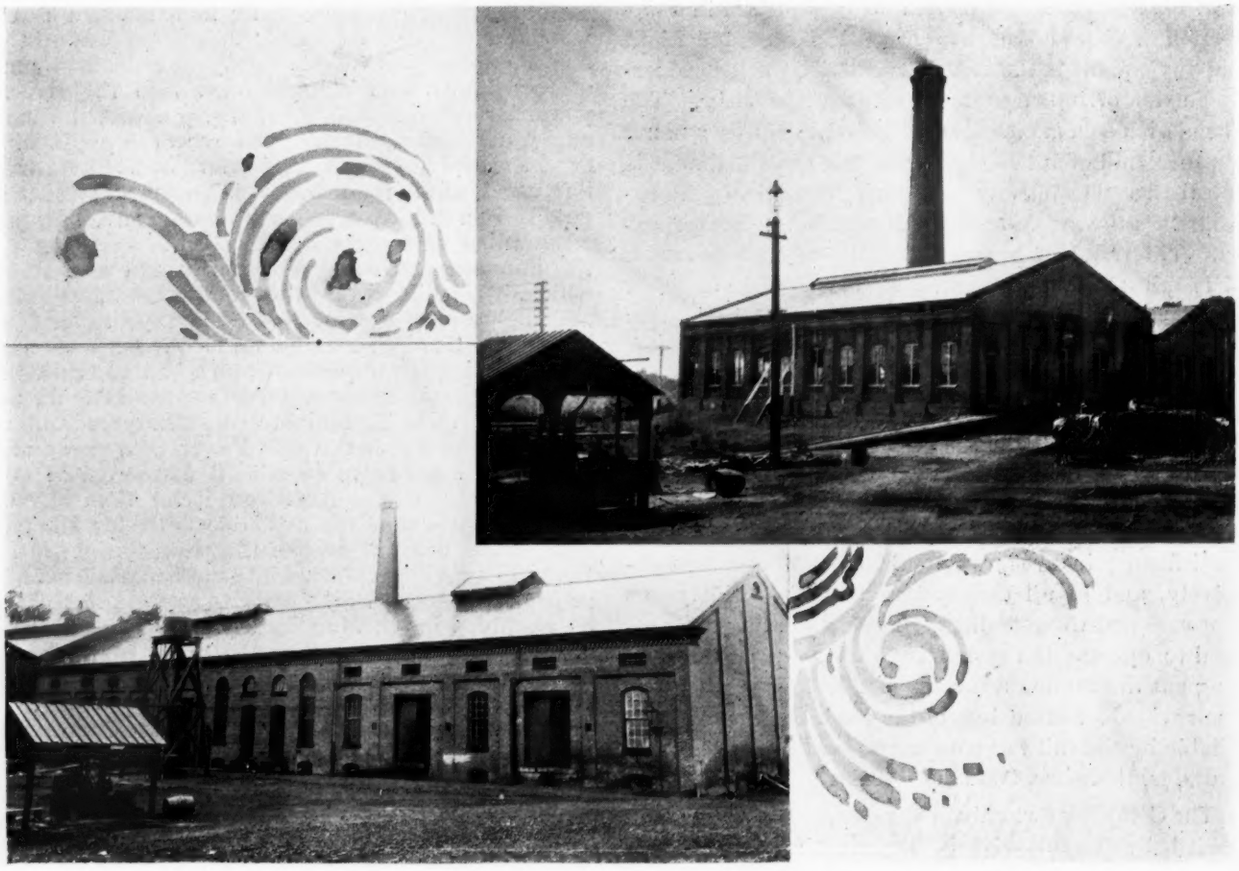
The principal stockholders of the Sacramento Electric Power and Light Company, as well as of the Central Electric Railway Company, are Messrs. Albert Gallatin, Horatio C. Livermore, Charles E. Livermore and others. The officers of the first-named corporation are Albert Gallatin, President; Horatio P. Livermore, General Manager, and Joshua Barker, Secretary, and it is to the energy and enterprise of these gentlemen and Mr. Charles E. Livermore, that the installation of this remarkable power transmission is due.

THE CAPITAL GAS COMPANY.

Up to the present time the requirements of the Sacramentans for gas and electric light and for electric power have been catered to by the Capital Gas Company, a powerful concern that was organized by the consolidation of the Sacramento Gas Company and the Citizens' Gas, Light and Heat Company. The then new concern was incorporated, on January 4th, 1875, with a capital stock of $40,000, which was subsequently reduced to $10,000 while at present the amount is divided into 10,000 shares at $50 each, making a total issue of $500,000. Among the original incorporators of the Capital Gas Company, and all of whom are now holders of its stock to a great extent, are names that are known the country over. Leland Stanford, Mark Hopkins, Charles Crocker and C. P. Huntington all had considerable holdings, as did Wm. Alvord, now of the Bank of California, Oliver Eldridge, of the Pacific Telephone and Telegraph Company, and B. J Tallant, the banker. In addition to these, the Capital Gas Company now has coupled with it the names of B. U. Steinman, Mayor of Sacramento and who is President of the Company; C. H. Cummings, Secretary and Treasurer; Frank Miller, President of the Bank of D. O. Mills & Co.; Benj. Welsh; Oliver Eldridge, who is Vice-President; H. H. Taylor and H. C. Woods of San Francisco, and others — hence it will be seen that the commercial antagonist of the Sacramento Electric Power and Light Company is supported by men of the soundest financial standing.

The industry of electric lighting was not entered into by the Capital Gas Company until 1887, when the business, apparatus and good will of the Pacific Thomson-Houston Electric Company was purchased. The company was exploited by Mr. F. G. Waterhouse, and constituted the first effort of the parent Thomson-Houston company to introduce its electric lighting machinery on the Pacific Coast; its "apparatus" consisted of one 12-lamp 2000 candle power arc lighting dynamo and one 25-lamp dynamo, which were among the first brought to the Pacific Coast; hence it is clear that the subject of this sketch is at least entitled to mention in electrical history.

At the present the Capital Gas Company is operating practically all the electric lights, both arc and incandescent, burned in Sacramento; but the electric power consumed is, on the other hand, most generally furnished by the Sacramento Electric Power and Light Company. Incandescent service is furnished both by the flat rate and meter systems, the rate for the latter being 15 cents per kilowatt hour, with a sliding scale of discount according to the amount consumed. For arc lighting by 2000 candle power lamps the weekly rates vary as follows: Nine o'clock circuit, $2; ten o'clock circuit, $2.25; twelve o'clock circuit, $2.75, and all night circuit, $3.50. The gas rate for lighting and fuel purposes is $2.50 per thousand cubic feet.



FIGURES 1 AND 2.—THE ELECTRIC POWER HOUSE AND GAS WORKS OF THE CAPITAL GAS COMPANY, SACRAMENTO.

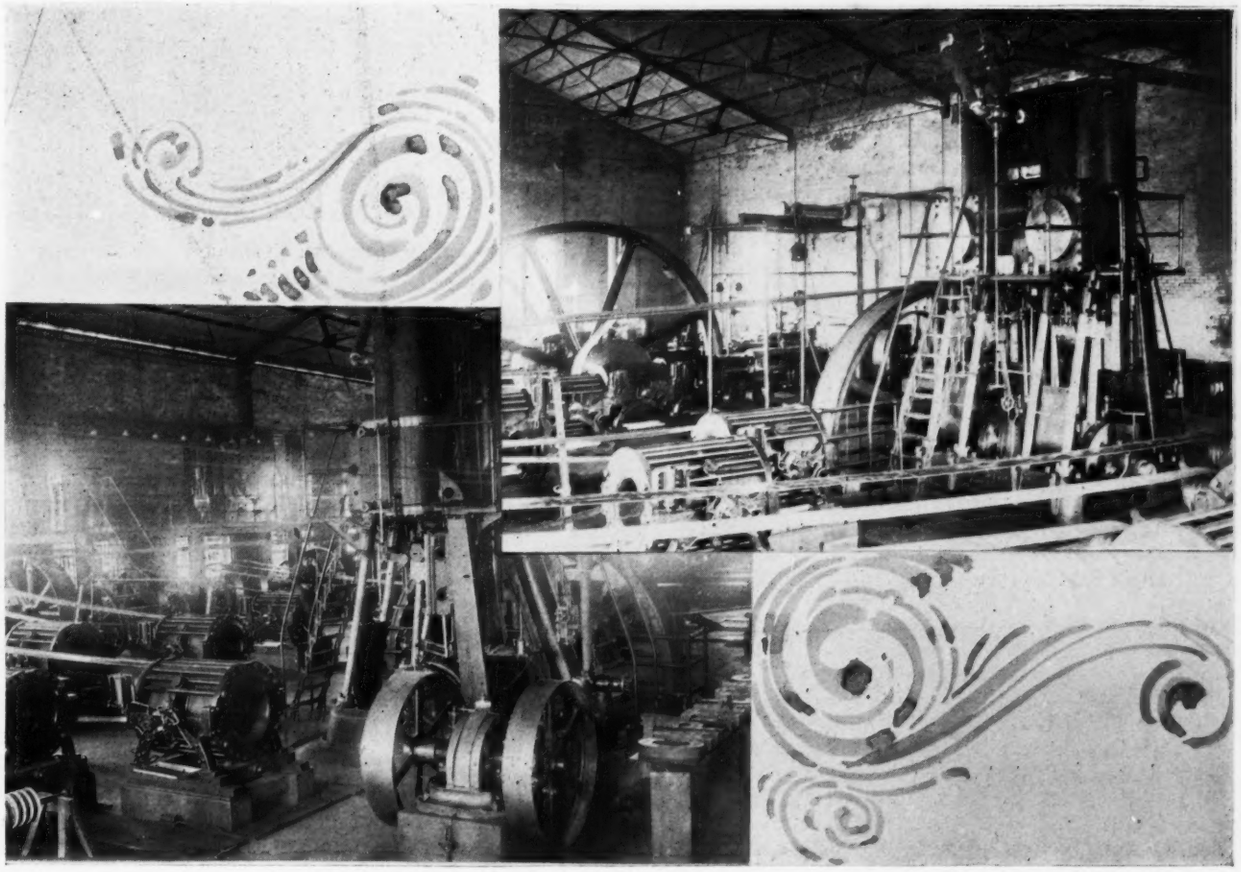
The power house of the Capital Gas Company (Fig. 1) is a substantial brick building having inside dimensions of 124 feet by 104 feet. It is of thoroughly fireproof construction, and contains no wood work or timber whatever, except the door and window casings and the mats about the high potential dynamos. It is divided by a fire wall into two portions, known as the dynamo and boiler rooms, the former being 124 by 64 feet in area, and the latter 124 by 40 feet. The roof over each is of corrugated iron, supported by iron trusses, and beneath the dynamo room is a basement 12 feet high. The floor of the dynamo and engine room is supported by brick piers and steel I beams which carry brick arches

over which is placed the concrete floor. The entire construction is most substantial, and is designed with the idea of preventing a recurrence of the destructive fire which consumed the plant in April, 1894.

In the boiler room is a battery of six Babcock & Wilcox water tube boilers having a working capacity of 900 horse power, and which operate under pressure as high as 140 pounds to the square inch. The boiler feed pumps consist of one 6-inch Dow pump having a capacity in excess of the requirements of the boilers, together with an auxiliary of two 4-inch Buffalo duplex pumps. In addition, the boiler room contains a 5-inch Buffalo duplex pump, to be used for fire purposes. A large horizontal flue extends along the rear of the boilers for a distance of over 70 feet, ending in the chamber of the brick stack. This stack, which is 140 feet high and circular in form, rests on a brick foundation that is

As is well known, the item of fuel has always been of serious concern in California, and, as a result of careful experiment, the Capital Gas Company has now adopted and is using Ione coal, under a forced draught of ¾ inch pressure. This is a lignite coal mined not far from Sacramento, and which has a market value of $1.80 per ton. It is only recently that it has been found possible to use Ione coal to any advantage, otherwise its low price, as compared with the rates of $6 and $7 per ton for ordinary coal, would have brought it into extensive use. The boilers are also fitted for burning Welch anthracite coal should it be necessary for any reason to change from Ione coal. The plant has coal storage bins for about 4000 tons for the electric light plant and for about 7000 tons for the gas works. The Company imports all coal direct.

The motive power for the electric plant consists of



FIGURES 3 AND 4.—INTERIOR OF THE ELECTRIC LIGHT PLANT OF THE CAPITAL GAS COMPANY, SACRAMENTO.

30 feet square, and its base, which is 18 feet square (outside measurement), contains the chamber, 13 feet square. At a height of 30 feet this chamber is brought to the cylindrical portion of the stack proper, and extends to the top with an internal diameter of 7 feet. Not only the stack but the entire station was laid out for an ultimate capacity of double the present size.

The condensing plant is located in the basement of the station, and consists of three Davidson condensers each having a capacity of 650 horse-power. The engines are connected to an exhaust header so arranged as to use one or more condensers at any time. Condensing water is taken from the Sacramento river, on the bank of which the station is located. From the hot well the water is passed through Baragwanath tubular heaters. The water is practically free from scale, as it never forms more than a mud scale 1-16 of an inch thick, which soon scales off.

three engines, each of which is belted direct to the countershafting, which is along the north wall of the building under the switchboard gallery. The first engine is a cross compound Corliss condensing engine, built by the Risdon Iron Works of San Francisco. It has a stroke of 48 inches, with cylinders 22 inches and 40 inches in diameter, respectively, and, running at 80 revolutions per minute with steam at 120 pounds, it develops 600 horse power. The next engine is a triple expansion marine type vertical, built by the San Francisco Tool Company, and which has a capacity of 400 horse power at 140 revolutions per minute. The stroke of the engine is 30 inches; the high-pressure cylinder has a diameter of 15 inches, the intermediate cylinder has a diameter of 24 inches, while two low pressure cylinders each having a diameter of 24 inches are used. In order to economize floor space, one of these low pressure cylinders is placed in tandem over the high pressure cylinder and the other

is in tandem over the intermediate cylinder. The third engine is a simple Reynolds Corliss, 20 by 48 inches, run condensing, and which delivers 250 horse power at 78 revolutions per minute.

These engines all belt together from their fly wheels to the line shafting, a double leather belt 30 inches in width being used on the Reynolds Corliss and rope transmission being used on the other two engines, the Risdon cross compound being equipped with ten 2-inch single manilla ropes and the vertical engine being equipped with the Link Belt Company's rope transmission, using 1½-inch manilla ropes. The driven pulleys of the countershaft are equipped with Hill clutch couplings, except for the vertical engine, which is so arranged with flanges as to be detachable, in order that, if desired, it may be at rest while the shaft is in motion. The countershafting runs at 272 revolutions per minute, is equipped throughout with self-oiling bearings, is 100 feet long, and its diameter varies from 5½ inches to 4⅞ inches. The driving pulleys on the countershaft are, wherever necessary, equipped with Hill clutches.

The generating plant consists of eleven 50 lamp Thomson-Houston arc dynamos and two 35 lamp arc machines of the same make. Also one "D 62" 500 volt Thomson-Houston power generator for the distribution of both light and power on metallic service, together with one 60 kilowatt Thomson-Houston alternator and two 120 kilowatt General Electric alternators. All leads from dynamo to switchboard are carried in iron-armored conduits under the floors and up along a wall of the station to the switchboard gallery, which is constructed entirely of iron and marble, with the usual fittings common to the latest type of fire-proof switchboards as manufactured by the General Electric Company.

Overhead distribution is used exclusively, and the pole lines and circuits for the various services embrace all the principal streets, while the entire city is covered by the arc circuits for public lighting. The main pole line from the station to the business centers consists of sawed Santa Cruz redwood poles, 16 inches square at the butt and 10 inches square at the top. Eight-pin cross-

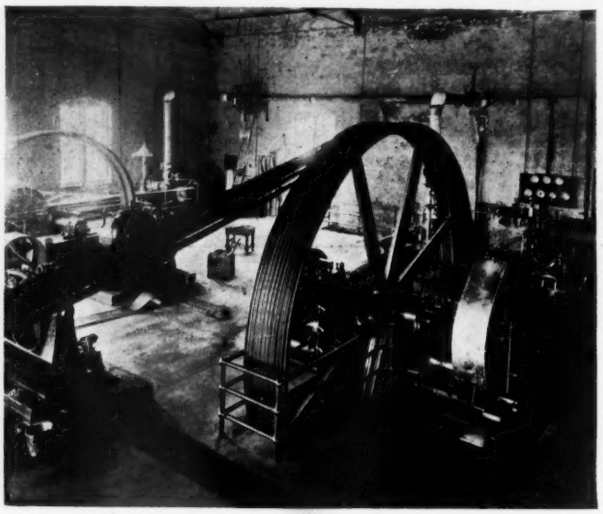


FIGURE 5.—INTERIOR OF THE ELECTRIC LIGHT PLANT OF THE CAPITAL GAS COMPANY, SACRAMENTO.

arms, 4 inches by 6 inches, are used, and the construction is very substantial.

The Directors of the Capital Gas Company have long since realized that it is the province of organizations of their class to furnish illumination in whatever form the public may demand, whether that be as gas or as electric light, hence in the prosecution of their lighting business they have given great attention to the development of their gas works. This is principally contained in an irregularly shaped building constituting the retort house, which has an area of 66 by 100 feet, and the purifying and lime house, having an area of 60 by 80

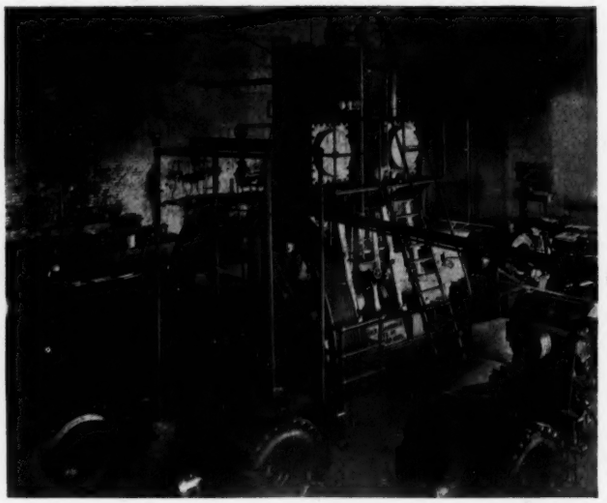


FIGURE 6.—INTERIOR OF THE ELECTRIC LIGHT PLANT OF THE CAPITAL GAS COMPANY, SACRAMENTO.

feet. In this combined building are contained the engine and pump rooms, the scrubber and purifying rooms and the lime storage. In the retort house are eight benches of six retorts each, each bench being heated with a half depth regenerative furnace. A six-foot setting of the Lowe double superheater, with all necessary pumps, injectors, elevating machinery, meters, steam and air plant used in the generation of water gas, are used. Two seven-foot MacDonald station meters, each having a capacity of 300,000 cubic feet per day, are here located, while on the grounds are three gas-holders, each having a capacity of 70,000 cubic feet. The gas produced is of 20 candle power absolute.

PERSONAL.

MR. G. GUSTAVSON has been appointed General Manager of the Oakland, San Leandro and Haywards Electric Road, vice F. M. Leland, resigned.

Mr. V. J. MAYO, has resigned the Superintendency of the Capital Telephone and Telegraph Company, and is at present in San Francisco.

MR. T. P. HORNSBY, representing the National School of Electricity, is organizing classes for the schools in San Francisco.

MR. MICHAEL T. O'DAY, M. S. E. E., Professor of Applied Electricity, University of Notre Dame, Indiana, is visiting San Francisco and other California cities for rest and recreation.

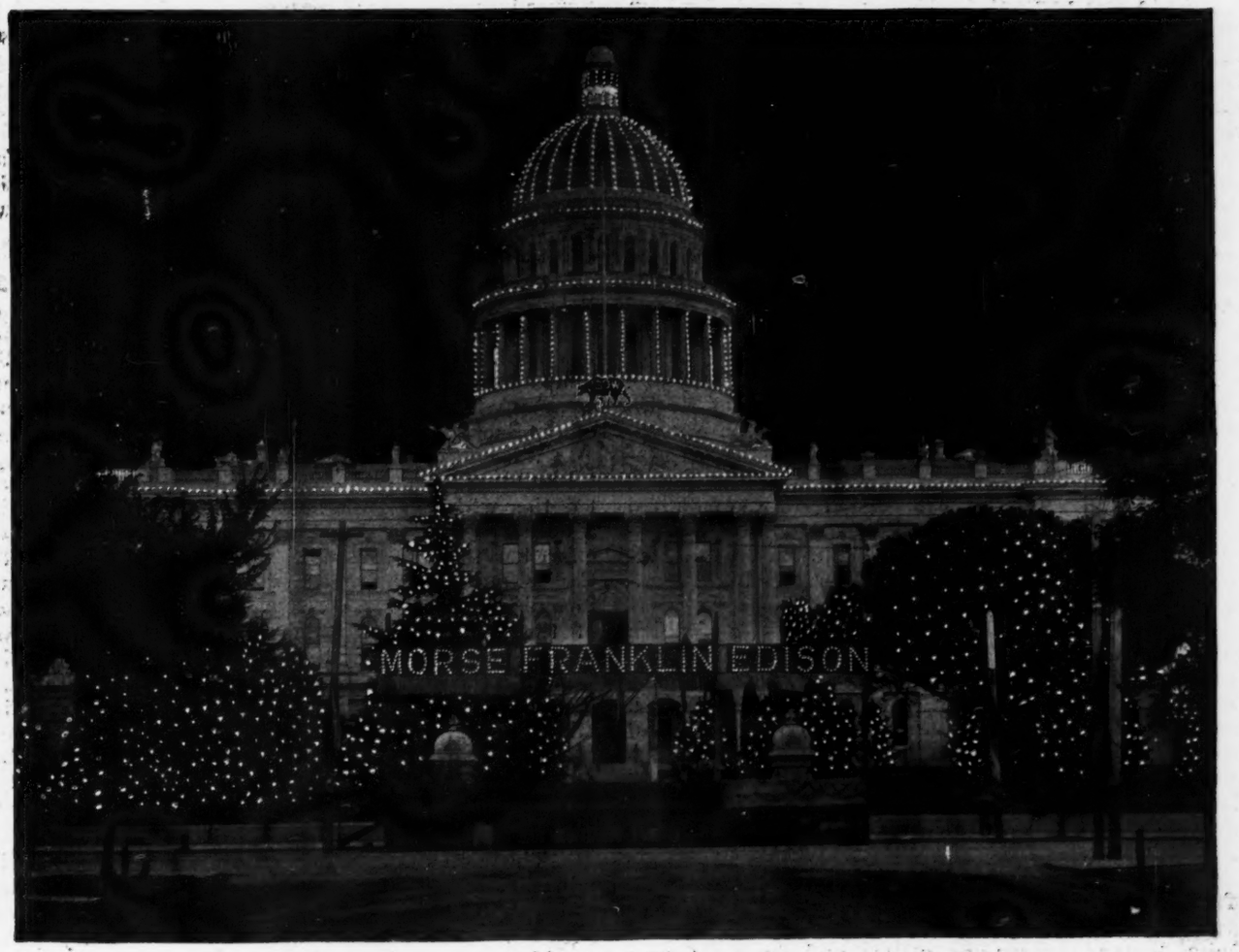
MR. FRANCIS O. BLACKWELL, Chief Engineer of the power and mining department of the General Electric Company, and who has been spending several weeks of his vacation on the Pacific Coast, has returned to the East.

MR. W. S. HEGER, universally known as a pioneer in the electric lighting business, has assumed the managership of the Pacific Coast office of the Westinghouse Electric and Manufacturing Company, with headquarters in the Mills Building San Francisco. His many friends on the Pacific Coast are pleased to know of his return and wish him unlimited success.

THE ELECTRIC CARNIVAL.

Resplendent indeed was the scene, when, on the perfect evening of September 9th the joy felt by the people of the city of Sacramento over the completion of an enterprise that assured a cheap power to its languishing industries, gave outbursts of approval in the decorations of gaudy carnival array, in brilliant illuminations, in electric pageants, and in the hospitality that has become proverbial to California and Californians. The occasion was one of triple jubilee; the State Fair, that has yearly drawn thousands to the Capital City, was in progress. Then it was "Admission Day"—the forty-fifth anniversary of the entry of California into the sisterhood of States—and thousands upon thousands of members of the Native Sons of the Golden West, which is the mightiest social organization in California, were gathered to honor the natal day of their beloved State. The success at the Fair had been unprecedented, and never before had the attendance to the celebration of the Native Sons and Daughters been so large, or had the "Parlors," as the lodges are termed, gathered in such good cheer and merriment. It was a gala day indeed, with its magnificent parades and sumptuous receptions, but its crowning feature was the "Grand Electric Carnival," to the success of which loyal Sacramentans had devoted weeks of time, and spent thousands of dollars. Nor were their exertions in vain, for never before has the world witnessed such a sight, nor never again can a community experience the novelty and enthusiasm of those who are proud in the knowledge that they have accomplished an undertaking never before attained.

Picture, if you will, broad thoroughfares forming the principal streets of a community whose long lines of low, two-story buildings, and with here and there modern office buildings and mercantile houses cropping far above their lowly neighbors, betoken a recent development into cityhood. Its smooth, paved streets and broad, well-kept sidewalks indicate a spirit of enterprise, and when, on looking further one finds some of the largest and finest retail stores in the West, he feels anew that Sacramento is fast becoming metropolitan in its way. But on this night its streets are densely thronged with people whose radiant, expectant faces speak of some approaching event, even were not these streets arched and bedecked in the most brilliant raiment of carnival colors, or were not the buildings, as far as eye could reach, simply ablaze with thousands of decorative lights. Everywhere, from the miles upon miles of bunting upon the streets to the paper boutonniers upon the lapels of many coats, were present the carnival colors of green and yellow and red to offend the æsthetic taste, yet withal to lend allurement and enchantment to the scene. Everywhere, from the top of the Maypole, nearly two hundred feet above the ground, to the harness on the horse of a peddler of chewing gum, were incandescent electric lamps seemingly without number, increasing by many fold the brilliance of the colors. Arches of light and arches of triumphal character spanned the streets. Yet others flashed out a cheering welcome, or told of the



Electric Illumination of the State Capitol on the Evening of September 9, 1895.

dawn of the day of progress or of a new era—"The New Sacramento."

Picture again, then, scenes with augmented crowds, which, though filled with merry-making and perchance revelry, are silent at the first strain of music, and with much tip-toeing and craning of necks, look eagerly down the level distance for the coming of the now-delayed procession. At last, in lurid outlines, the royal pageant approaches, slowly and majestically, until now before us is "Old Glory" outlined in colors of fire. With one accord the voices of the people are raised in loyal cheer, for in all the splendor of carnival attire, in all the expectancy of wonders electrically wrought, that grand old flag appearing in the National float, appropriately leading the procession, awakened a patriotic sentiment in every heart.

As to the pageant itself, any one who is familiar. not only with the effects which may be obtained through the artistic arrangement in decoration of allegorical floats, but also with the extreme brilliancy of electric cars elaborately illumined for trolley parties, will experience no difficulty in conceiving an idea of the scene. In the National float the flag was 7½ by 12 feet in size, and the stars and stripes were excellently portrayed by red, white and blue incandescent lamps. The body of the float represented a camp scene covered with natural grass and flowers all illuminated by the subdued light from incandescent lamps artfully concealed. At the front of the float was the National shield in red and white lights, with silver stars surmounted by an eagle, while stacks of muskets and a cannon, on either side of which were cannon balls, were placed upon the grass. In the rear was a grizzly bear in the attitude of an intruder in the camp. The float, which was the conception of Director-General J. O. Coleman, was very tastefully draped in flags and bunting, and was illuminated by 525 16-candle power lamps. The float was mounted on a flat car, which was pushed by an illuminated trolley car containing a number of Federal officers and officials of the Sacramento Electric Power and Light Company.

The State float followed this, in the center of which was a golden throne on which sat "California," and seated at her feet was "Sacramento." Aside from the festoons of light interwoven amidst draperies of plush and satin in blue and gold, the magnificent bouquets of cut flowers, illuminated with miniature lamps, constituted the chief features of interest. As with the National float, the car bearing the State float was pushed by an illuminated trolley car containing officers of the State of California.

The Fruit and Flowers' float bore the carnival colors of cherry-red, apple-green and poppy-yellow. It was profusely garlanded and bedded with the choicest of fruits, flowers, evergreens, palms and ferns. Queen Flora's throne was supported on either side by illuminated wreaths mounted on silvered lattice work, in front of which was a vase holding ten large California poppies wrought in electric lights. On each corner was a brass post four feet high, surmounted by colored lights, and on the center of either side was an illuminated shield, which, together with other decorations, consumed the 300 lights that were used on the float. The trolley car pushing the Floral float contained the grand officers of the Native Sons and Native Daughters of the Golden West. Then came two illuminated trolley cars, lavishly decorated with bunting and colored lights, carrying members of the Sacramento County Pioneer Association.

These constituted the floats constructed by the Carnival committee, and which were the most artistic. The employes of the railroad shops of the Southern Pacific followed with twelve floats of their own design and construction, that represented the various trades employed in the great shops of the Company. Among the designs submitted, worthy of special mention, were the Electric Locomotive, built by the Machine Shop; the Beehive, by Car Shop No. 5; the Flaming Cupola, built by the Foundry and Pattern Shop; the Electric Star, built by the Car Machine Shop; the Electric Furnace, built by the Rolling Mills; Franklin's Kite, by the Boiler Shop; Electric Hammer, by the Blacksmith Shop; Ornamental Designs, by the Paint Shop; Mechanical Designs, by the Car Shop, and an Electric Fountain, by the Copper and Pipe Shops.

The route of the procession followed through three miles of streets, over which were various electric arches and signs, among which were the following:

The Horse-shoe, containing 225 white 16-candle power incandescents;

The Maypole, containing 510 red, yellow and green lamps;

The "New Sacramento," 500 red lamps;

Progress, 300 yellow lamps;

Welcome, 400 white lamps.

Perhaps the most striking of these was the Maypole. From the summit of the liberty-pole, 185 feet high, were arranged six strings of 16 candle power lamps in multiple, each string containing 85 lamps, in carnival colors, which was so arranged as to give the effect of spirals of different colors encircling the May Pole. The colors started with a red appearing first on one string, following as second on the next and third on the third, and so on, thus forming the spiral effect. The lamps were operated at a potential of 115 volts, and were supplied from the three-phase incandescent circuit of the Sacramento Electric Power and Light Company.

Without doubt, the illumination of the State Capitol building presented the most brilliant appearance, and, together with the illumination of the grounds, afforded a scene surpassing in effect that of any single similar effort heretofore attempted. The roof and dome of the Capitol building were outlined with 2000 16 candle power incandescent lamps, and, as the bear of the Native Sons of the Golden West which surmounted the roof contained 600 lamps, and the interior of the building was illuminated with 600 lamps, there were 3200 lamps used in and on the building. Surmounting all were 12, 2000 candle-power arc lamps placed on the apex of the dome. In addition, the twenty-four trees facing Tenth street, and forming the foreground of the Capitol, were brilliantly lighted with 2000 yellow, green, red and white incandescent lamps.

The methods of wiring utilized in effecting the illumination of the Capitol and grounds are interesting, as it can be readily understood that the installation of such a large number of lamps on an ordinary system would be impracticable because of the fact that no station carries so large a reserve capacity as would be necessary to meet such unusual demands. The Capitol itself, therefore, was lighted from the regular 1080 volt incandescent alternating system of the Capital Gas Company, each circuit consisted of 100 volt multiples of 16 candle power lamps in series direct across the primaries. These multiples were of varying numbers of lamps. On the rows forming the eaves of the roof, for instance, 27 lamps were placed in each multiple, while 10 lamps constituted a multiple on the vertical columns, and on the dome from 20 to 30 lamps were placed in parallel. Great care was necessary in effecting the installation to prevent the occurrence of grounds, as the roof of the building is entirely of metal, hence sockets were placed on wood strips which were laid upon all flat surfaces or temporarily secured to the curves. The illumination of the trees was effected from the railway circuits of the

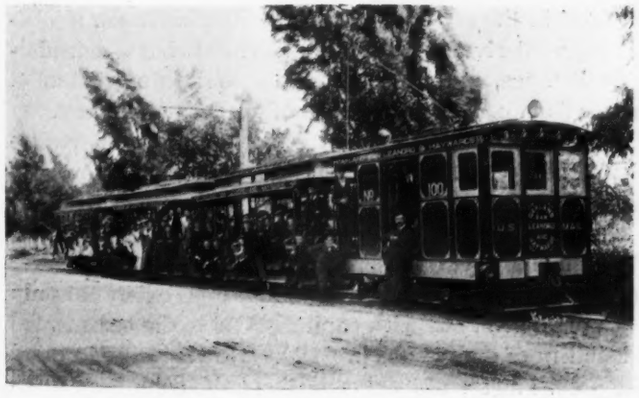
Central Electric Railway Company, which is, as stated, operated by power from the American river, at Folsom. Series multiple wiring was used throughout, the circuits being made up of five multiples of lamps in series, each multiple carrying from nine to 11 lamps. There were generally ten such series multiples to each tree. The lamps tinted with carnival colors, together with many white lamps, were used, the only deviation from the usual color arrangement being that twice as many green lamps as any other color were used.

The bear appearing on the roof the Capitol was illuminated by current taken from the Folsom power. It was about fifteen feet long by eight feet high, and contained 600 16 candle power lamps wired in simple series and operated from the trolley circuit.

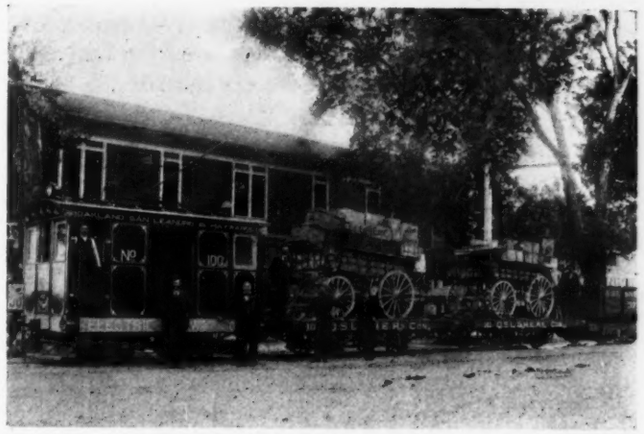
THE HAYWARDS ELECTRIC LOCOMOTIVE.

The Oakland, San Leandro & Haywards Electric Railway Company is one that has always been prominently before the public and the electrical interests, because of its enterprise and the many features of superiority the system possesses. Embracing in all twenty miles of track, the system begins at the foot of Washington street in Oakland and extends thence through the business portion of the city to East Oakland and on through the towns of Fruitvale, Melrose, Fitchburg, Elmhurst, San Leandro and Haywards, terminating in a pleasant canyon at the eastern limits of the last-named town. A branch line, a mile in length, runs from the main road to San Leandro, and throughout practically the entire line the road parallels the Southern Pacific system, which before the advent of the Haywards line had a monopoly of the traffic. From the outset the competition between the steam and electric lines has been very keen, and it now appears to have reached its zenith, as the Southern Pacific Company has put on extra local trains with superior service and is running at very close intervals with materially reduced fares.

It is with the intention of meeting this competition all along the line that the electric road has placed an express service in operation, and will at the earliest opportunity effect connections by which passengers can be landed through from any point to San Francisco. At present the Southern Pacific Company controls the through commutation business between Haywards, San Leandro and San Francisco, but the bulk of local traffic is by the electric line, and in addition, a new and profitable industry has been developed by the carrying of farm products to Oakland and the metropolis. The very productive region in and about Haywards has never contributed materially to the income of the Southern Pacific Company because the freight rates that have prevailed have been so high that it has been cheaper to carry the garden truck in by team than by rail. In order to secure this trade the Haywards line accepted the recommendation of Mr. F. M. Leland, then General Manager of the road, and built the electric locomotive known as "No. 100" and shown in the accompanying illustrations. This is equipped with two 50 horse-power motors and a series parallel controller, and the unusual weight of the locomotive—21,400 pounds—is due to the fact that under its floor is placed a layer of railroad iron. Steam locomotive practices are followed out to a large extent as, for instance, locomotive driving box brasses are used and the locomotive is equipped with air brakes.



THE HAYWARDS ELECTRIC LOCOMOTIVE.



THE HAYWARDS ELECTRIC LOCOMOTIVE.

The air compressor forms a feature of interest. It is operated by an independent electric motor manufactured by the Electrical Engineering Company of San Francisco and having a capacity of three horse-power. The motor is mounted on a single base with a duplex air pump which the former drives through a single reduction gearing. Through an ingenious arrangement of the Electrical Engineering Company's starting rheostat and a pressure valve of ordinary type, the entire mechanism is automatic in action and requires practically no attention. This compressor is due to Mr. G. Gustavson, Master Mechanic and Superintendent of the road, and is used with the greatest success. In addition to the locomotive, the freight or passenger trailers hauled by the electric locomotives are equipped with air brakes, as are also the 32-foot combination cars operated on the main line. The whistles are also operated from the same source.

The distinctive feature of the express service of the Haywards Electric Road rests in the plan adopted of running the loaded wagons on the cars and carrying them to destination, which can be accomplished quicker and more cheaply in this way than in any other manner. The locomotive is in hard service regularly on week days and performs even harder work on Sundays in hauling picnic trains.

AS OTHERS SEE US.

The ELECTRICAL JOURNAL, published at San Francisco by Geo. P. Low, is the latest electrical exchange to hand. It is designed to represent the electrical interests of the Pacific Coast and has a large amount of local information. —[Canadian Engineer, Toronto, Ont.

.....As our Golden Gate contemporary [THE ELECTRICAL JOURNAL, San Francisco] is a handsome paper, well edited, and something after our own style, we predict and hope for it a large measure of success.—[The Electrical Journal, Chicago.

The Journal of Electricity.

An Illustrated Review of the Industrial Applications of Electricity, Gas and Power.

EDITED BY

F. A. C. PERRINE, D. Sc., and GEO. P. LOW.

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EDITORIAL.

AN OPPORTUNITY LOST.

Without doubt the thousands of spectators who found much to admire in the most elaborate display of lighting effects witnessed during the recent Electric Carnival pageant at Sacramento, will share the pangs of regret experienced by the publisher who would record such scenes in words of description and in artistic illustration, on learning that despite the efforts of several local photographers there is not to be obtained a single illustration of even a single float that would make a creditable appearance or that is worthy of reproduction. That such a situation can exist in an enlightened American city which aspires to National prominence is not only a matter to be deplored, but tends to lead to the conclusion that Sacramento affords a promising field for an enterprising photographer.

"WHAT'S IN A NAME."

The last issue announced a change in the name of this publication from that of "The Electrical Journal" to "The Journal of Electricity." This early change has been occasioned by the almost simultaneous publication of two periodicals with the same title. Whatever may be the facts as regards the rightful ownership of the name in question—"The Electrical Journal"—we deem it advisable, in the interests of our readers and of harmony, to take this step to prevent all further confusion which might occur on account of the title.

The original idea of publication and the adoption of the name were very much earlier than the actual date of the printing and copyright, and we believe that our plans were sufficiently well known to the electrical fraternity throughout the country to have avoided this coincidence. From the information we have been able to gather we firmly believe that we were the first to adopt the title which we now relinquish. We were not the prior in the field; and since the two journals have been published we believe that our methods and matter will not gain by being confounded with those of our contemporary.

We desire no newspaper controversy in regard to the question of the title. This paper will continue to stand upon its own grounds, and the success it has already attained will not be forgotten because of this change. Nor are our plans altered in any respect by the announcement that it is now to be called "The Journal of Electricity, an Illustrated Review of the Industrial Applications of Electricity, Gas and Power."

THE NEWER SACRAMENTO.

The columns upon columns of complimentary matter that have appeared in the lay press eulogizing the enterprise of the men who have made Sacramento famous as being the first American city to demonstrate the practicability of long distance transmission of power at high voltage, have told most exhaustively of the success achieved, but what has been said in engineering papers concerning the electrical distribution of power in manufacturing centers, and which is now about to be put into practice in that city, has received little, if any, attention on the part of the public. From Folsom there has been delivered, and is today in use in Sacramento, a very considerable amount of power, and it is understood that during the coming winter an equal or greater amount of electrical energy will be delivered over the transmission lines of a new company. In addition, it is understood that the plant of the present gas and electric company is to be brought to the highest degree of efficiency attainable, whether that be in the use of steam or gas engine equipments, in order that it may carry out its plan of competition to the fullest extent, and while no doubt the residents and users of power will be greatly benefited by the availability of power which may be furnished in either large or small amounts, and always at the lowest possible cost, electrical engineers will be especially interested in the result of the competition between electrical power derived from waterfalls situated at a considerable distance, and the generation and transmission of power from coal over the lines of the local company.

It seems that the public is at last about to realize that the blight of high-priced fuel has brought, or may be made to bring, the blessing of cheaper electric power, and while, of late years, electrical engineers have not doubted the technical feasibility of transmitting power over great distances, a serious doubt does exist, not only with engineers, but with capitalists as to the commercial feasibility of many such projects. Bearing ever in mind the potent factor of local conditions, the cold, hard question that must receive equally impassionless consideration, is, Which has the greater earning capacity, the electrically transmitted power of a distant waterfall or the electric power from a central station? No one doubts that both of these systems are engineering successes. As the business of the two systems is to deliver electrical energy to the market, the problem, so far as Sacramento is concerned, resolves itself into the question, Which can

do the work cheaper, the central station consuming coal, or the transmission plant consuming interest on the additional expenditure necessary to develop the water power, and render its energy available?

Unless consolidation or other combination should occur, there is reason to believe that Sacramento is on the eve of a struggle for commercial supremacy between the two electric systems which it is so fortunate as to possess. One side is ranged on the vantage ground of abundant water power, but its forces are crippled because of the heavy interest charges that must be met; the opposing side is free from bonded indebtedness, its interest charges are light, and, if need be, by the substitution of gas engines for its present steam plant, and by effecting changes in its system of distribution, it can render service at exceedingly low rates. It is the outcome of the struggle that electrical engineers are awaiting with bated breath, but from it all cheaper and cheaper power with greater and yet greater prosperity awaits the manufacturing interests of the city.

This, then, is the good fortune that in all probability awaits the newer Sacramento.

THE OPPORTUNITIES OF ELECTRO-CHEMICAL ENGINEERING.

Electrical engineering in the fields of dynamo design and the application of electricity for lighting and motive power has become a question of detail to such an extent that little remains for the ingenuity of one wishing to make any advances along any new lines. The high frequency work of Tesla and Thomson presents wonderful possibilities, but as yet the application of high frequency transmission exists only as a possibility, and the experimenting yet to be done requires a genius of high order, aided by an unusual amount of capital. Electro-chemistry, however, is rapidly advancing along the lines of laboratory practice and technical workmanship toward becoming a true part of the engineering profession.

The reduction of aluminum by the means of the Cowles, Herault and Hall processes have already been reduced to a scientific basis. The electrolytic refining of copper has long since passed through its preliminary stages, and the great works in which thousands of tons of copper are refined every year by means of electrolysis attest its superiority over furnace refining methods heretofore in use. But, though bleaching by means of salts obtained from electro-decomposition was one of the earliest attempts of the electro-chemist, no wide introduction of the process has been made up to the present time. Bleaching salt may undoubtedly be obtained by electrolysis, but the details of the plant necessary for bleaching fabrics with complete success have not been worked out. The same is undoubtedly true of the electrical tanning of hides and the electrical production of disinfecting fluids. Gradually, little by little, we are learning what is necessary to advance these applications of electrolysis from the experimental to the commercial stage.

In general, the electrician attacking the problem is deficient in his knowledge of chemistry, while chemists of sufficient ability rarely have enough knowledge of the electrical faults in their systems. A new training is therefore needed for the engineer to enter upon the field of electro-chemistry, but to men who combine the knowledge of chemical manipulation with a thorough training in electrical engineering not only are these fields open, but a vast number of other problems are presented which await solution and promise fortune for their solver. It must have struck every man who read Mr. Keith's paper on electro-metallurgy of gold and its discussion before the British Institution of Electrical Engineers, that the paper claimed discoveries in chemistry which were but barely criticised by the eminent electrical engineers who took part in the discussion. Whether the electrical calculations were true or not depended upon the truth of certain chemical theories, the knowledge of which was wanting, and the criticisms were consequently of but little value, either as approving or condemning the process.

The most recent advances in electro-chemistry involve still more the underlying theories of chemical action. The synthesis of chemical compounds has been for many years the dream of the chemist, and, though the chemists have stated the possibilities of such synthesis, little advance has been made by any truly chemical process. Within the last few years we have been astonished by the immediate introduction of two electro-chemical processes accomplishing synthesis. The first of these is the manufacture of carborundum by Mr. Acheson. This grinding powder, which has proved itself to be superior to emery, is now so well introduced that the company manufacturing it has contracted for one thousand horse-power at Niagara Falls.

The later discovery of the synthesis of calcium carbide by means of the electric arc, while being simply an accidental discovery, nevertheless opens far wider possibilities and is the more attractive discovery to both the chemist and electrician. The simple immersion of this material in water produces acetylene gas, while recent experiments indicate that a large number of hydro-carbon compounds can be simply and economically manufactured by similar processes. Moissan, by means of his electrical furnace, has not only fused carbon and many metallic oxides, producing by these means diamonds and other gems, but has lately effected a synthesis of hydro-cyanic acid, again presenting wide possibilities to the electro-chemist.

Not only does this field of electro-chemistry present an attractive branch of research, but also the electrical generation and transmission of immense powers at low cost admits of the possible commercial application of electro-chemical processes, which up to the present time have been hindered by the necessarily expensive means of generating great quantities of energy.

A prophecy of what will be in the future of electro-chemistry would be, indeed, idle, but the indications of the field to prospective students and experimenters is right and proper. More and more the advance of the world is taking place by the applications of scientific

methods, and no field of study requires more thorough training than electro-chemistry does in the science of electricity and the science of chemistry.

ON CENTRAL STATION ECONOMY.

It may seem a difficult statement to support, but it is nevertheless true that electricians as a rule pay too little attention to the value of electricity as a means of the transmission of power in their own plants. It has only been within a very few years that the machine shops of the electrical manufacturers have been equipped with electric motors, even where such power was daily run to waste in the testing of dynamos on lamp loads, and to-day a general inspection of our best-equipped lighting and power plants will show great disregard of the saving to be obtained by the use of small electric motors in the place of small steam engines.

Perhaps because it is difficult to ascertain the power consumed in feed pumps, blast fans, hoisting engines and other small motors, often used by a large plant in great numbers, it is taken for granted that the steam they use is only an inconsiderable quantity. But when we reflect on the fact that a ten-horse-power engine, running under favorable conditions of load, will consume as much steam per hour as will be required for thirty or forty horse-power delivered by the main engine of a well-equipped plant, we are bound to come to the belief that, aside from steam leaks and pipe condensation, a number of small engines about a plant may produce a very appreciable difference in the annual coal bill. The auxiliary engines of a generating plant rarely run under favorable conditions of load, and the elements of steam leaks and pipe condensation are by no means inconsiderable items. Feed pumps and blast engines must have ample capacity for the duty required at the full load of the station, while the maximum duty is rarely if ever required, and as a consequence the engines driving them run under the worst possible condition of economy; the packing of valves and pistons being continually watersoaked are almost always in a leaky condition, while the condensation in the large steam pipes with which they must be fitted, generally amounts to much more than the steam required for furnishing power.

Aside from these actual steam losses, such connections are a continual menace to the plant itself, and in more than a few cases the breaking of an insignificant steam pipe has occasioned troubles affecting the whole plant.

Several of the best English engineers have called attention to the fact that such losses might be largely diminished by the substitution of electric motors for all kinds of auxiliary power in use about a central station, but unfortunately for the best plant economy, the idea does not seem to have taken root deeply in this country. The question as to what is to be done when the main engines are shut down may be answered in the case of a large plant, that the main engines are never shut down, and even in stations where the engines are shut down while the boilers are still under steam, it yet holds that there will be greater economy obtained from a single engine driving a generator for the various motors in use than by the operation of many steam motors.

Steam boilers, feed pumps and other auxiliary engines are time honored institutions. We know that they will do the work day in and day out, and we know that they are used in steam plants to the thousands of horse-power while one is counting on the fingers the installations of electrical apparatus for such service. Where lies the advantage and the great need for so strict an economy? Aside from the fact that every undertaking must be made to pay a maximum net income, there remains for the electrical engineer the continual exploration of new fields of service.

The economical generation of electricity may solve the perplexing problem of the power for town manufactures. Were it possible for central stations to deliver electricity at the terminals of the motors situated throughout a manufacturing district at fifty, sixty or even eighty dollars a horse-power per annum, there would be few factories in any of our cities that could afford to maintain their steam engines and boilers. Some of our present central stations are contracting for city arc lights at approximately ninety dollars per horse-power per annum, and the charge includes the interest and depreciation on the lamps, besides the expense of carbons and trimmers. But to supply a manufacturing city with power for its factories, it is necessary to generate the power much more economically than can be done by the factories with their own steam plants. In the first place, the ease of the transmission of electricity makes possible the location of the generating plant in the most advantageous position.

Condensing water and cheap coal handling may be obtained where either or both are impossible to factory engines. But though these are items of original advantage, the competition between the power from a central station and from a local plant must yield a profit to the central station which can only be assured by an unheard of economy in operation. It is in the favor of plants for the transmission of power by the means of electricity that such economies are a possibility.

Not every city is fortunately located in reference to water-power, but, on the other hand, very few manufacturing cities depending on steam power are so situated that the greatest economy of steam generation and coal handling may be practiced by the majority of power users. This admits a considerable margin of profit to a central station for the distribution of power, provided the greatest economies are practiced at the generating station. Dr. Emory has pointed out that water power is not necessarily a cheap power on account of the great expense involved in the hydraulic plant, and if the power developed by water must be transmitted to a great distance, it is unquestionable that in many cases a cheaper power could be distributed to a district from a steam generating station. This most obvious field for the transmission of energy has been little attempted. But a future advance in the transmission of energy may be profitable where electricity is generated by a steam plant, and sold to the users of power throughout large manufacturing cities.

Literature.

THE PRACTICAL MANAGEMENT OF DYNAMOS AND MOTORS, by FRANCIS B. CROCKER, Member A. I. E. E., Professor of Electrical Engineering Columbia College, and SCHUYLER S. WHEELER, D. Sc., Past President A. I. E. E, Electrical Expert of the Board of Electrical Control, New York City, etc.; 206 pages, 12 mo. cloth, 99 figures, circuit diagrams, etc. Third edition, revised and enlarged. Published by the D. Van Nostrand Company, New York, 1894. Price, $1.00.

The dynamo attendant who has for years laboriously collected bits of information about dynamos and motors, and has perchance arranged a scrap book that he may "dig up" knowledge concerning the connections of this or that machine, or that on the occurrence of trouble he may find a way to apply a remedy, will welcome the third edition of this work, the title of which tells just what it is. It is not easy to think of a disease that a dynamo or motor is heir to that is not diagnosed and prescribed for in a clear, comprehensive way, and in a manner that is satisfying. The plan of first conveying an understanding of the normal functions of machines is adhered to, in doing which numerous circuit diagrams are given, together with many illustrations and descriptions of practical detail peculiar to the dynamo room. Knowing the normal state, any abnormal condition will be readily perceived, from which is obtained the symptom of trouble that, through Crocker and Wheeler's book, will quickly suggest a cure. It is not a book dealing with generalities, in typical cases or in scientific terms. It deals only with conditions as found in the dynamo rooms of central stations and isolated plants, and, what is equally significant, it discusses these conditions in plain words, whether the theme be the proper splicing of belting, the making of efficiency tests, the uses of the equalizer bar or the problem of running alternators in parallel. Considerable space is also given to the consideration of machines requiring especial directions, such as the Thomson-Houston, Brush, Wood, Sperry and Excelsior arc dynamos, all connections, details and peculiarities of which are shown.

The clearness, thoroughness and genuine merit, together with its low cost, make the work one that should become the text book of every person who has to do with the actual care and operation of dynamos and motors.

ELECTRICITY IN PLANT GROWTH AND LIGHT IN CHEMICAL DECOMPOSITION.

BY LIEUT. W. STUART-SMITH, U. S. N.

Many experiments have recently been made to determine to what extent electricity can be utilized as an accelerator of plant growth, these experiments covering the use of earth currents which act directly as a stimulant to the plant roots, and the effect of the light from powerful arcs acting upon the stems and leaves. The results obtained by both these methods have been so fully described in the technical and daily press that only a brief mention of them will be made in this paper, the object of which is to give a probable reason for the great variation in plant growth from year to year when there is but little apparent difference in the climatic conditions, and also to offer a possible explanation of the action of light in producing chemical decomposition.

For accelerating growth by the stimulating effects of a current, the experiments have been made by placing bare wires in the ground, located in such a manner that the current, in passing from one to the other, would make considerable use of the interlacing roots, which, on account of the sap, no doubt have a considerably higher conductivity than the moist soil. The conductivity of the sap is probably much higher than that of the surrounding moist earth, owing to the many contained elements which are extracted from the soil. Tests in this direction have been made by Prof. C. D. Warner at the experimental station at Amhurst, Mass., and "roots of certain vegetables and tops of others were found to be greatly enlarged under this process. In fact, all plants were found to be stimulated by a current of certain strength. The physiological effect of electricity upon plants, although not yet definitely understood, is probably similar to that experienced by animal tissues."

If the results of these experiments be confirmed, it may point to a possible value of ordinary earth currents in aiding vegetable growth. Such currents are known to exist, and at times they become so severe as to interfere with the action of telegraph and other electric lines using grounded wires. They are particularly heavy during so-called magnetic storms, but these, being of short duration, can hardly be expected to have much effect on plant life. It is possible, however, that carefully kept records will show that over a large area during some years the earth currents may be steadily much above the normal, while during other seasons they may be much below. If this is true, an examination of these and crop records might possibly show heavy crops corresponding with heavy average earth currents, and vice versa. It is the writer's recollection that some correspondence has been found between crops and sun spots, and if this rests on good authority, earth currents may be the cause, as magnetic disturbance on the earth certainly does correspond with activity in the sun.

The favorite method with experimenters is to make use of the light from an electric arc which is known to be rich in actinic rays. Many experimenters have entered this field, and the result of their work is to prove beyond a doubt that by extending the time during which plants are under the influence of light, much can be done in the way of accelerating their growth, and even causing fantastic growths. By regulating the distance of the plants from the source of light, gradations of forcing can be accomplished, and with plants close to powerful uncovered arcs the tops can be forced to such abnormal growth that the roots are unable to supply the requisite moisture, and the plant dies. All this is the result of the action of the actinic rays in producing decomposition of carbonic acid, thus supplying the material necessary for plant formation. An obvious extension of these experiments is to provide screens which will absorb the short invisible waves in a greater or less degree, and which can be regulated in such a manner that various portions of the space under cultivation can be supplied with actinic rays in accordance with the demand as determined by examination of the growing plants.

In hot-houses or confined spaces where the composition of the atmosphere can be regulated, the supplying of greater or less quantities of carbonic acid, moisture, etc., as well as regulating the actinic rays, will permit of a much wider control, and the possibilities of control will reach a maximum. if, in addition to the regulation of light and carbonic acid above ground, the roots are stimulated to greater activity by the use of regulated earth currents as above, care being taken to provide the soil with such constituents as the various plants require in addition to the carbon received from the atmosphere. Perhaps the greatest benefit will be derived by those plants which require to be raised from the seed each year, as perennial plants which are systematically subjected to enforced growth may become finally weakened by the process. Nevertheless, if the roots can be properly stimulated to keep up the supplies needed by the accelerated top, it is possible that the strength can be main-

tained and even increased to such an extent that many times the normal size natural to the bush or plant can be attained.

This leads again to the subject to discuss which this paper was written, viz., the variation of crop growth from year to year with but very little apparent difference in climatic conditions. The experiments made confirm what has long been well known, viz., that actinic rays are requisite for plant growth, their office being to decompose carbonic acid, from which the supply of carbon is obtained. Every photographer knows that from day to day the amount of exposure necessary to make a good negative is subject to wide variation, but probably comparatively few of those who makes pictures are aware that such variation extends over entire seasons, and these for many months at a time as much as four or five times the normal exposure is necessary, while at other times, for many months perhaps, not more than one-fifth the normal exposure is required. Nevertheless, such is the case, and it is demonstrated that under conditions that are the same, as far as the eye can detect, that is, clear, blue sky, etc., the actinic power of sunlight, as received at the earth's surface, may vary as much as 1000 per cent. for periods extending over as many months as are required for a season's growth of crops. Since actinic power of light is necessary for the best growth of plants, it is at once seen such wide variations must produce corresponding variations in vegetable growth.

It is not the purpose of this paper to discuss the causes producing such variations in the actinic power of light. It may be caused by some absorbent in the earth's atmosphere, or by some nebulous mass coming between the earth and sun of such extreme attenuation as to have no effect on the longer waves of the spectrum and yet be capable of absorbing the actinic rays, or, which is more probable, it may be due to the sun itself, the light having more actinic power during periods of great activity, such as exists during the regular recurring sun spots. It was many years ago suggested by some indefatigable collector and comparer of statistics that crops seemed to bear some relation to sun activity, but no explanation was attempted. The camera furnishes means by which the activity of the light from year to year can be readily recorded, and meteorological stations would do well to make such observations a part of their regular work, and at the same time carry on a systematic study of earth currents. A study of such records might make it possible to closely predict the condition of the crops for a coming season.

Since the action of light in producing chemical decomposition is of the utmost importance in plant growth, some attempt to explain how light acts to produce such decomposition may not be out of place in this connection. Manifestly this action cannot be produced by any heating effect caused by the absorption of the light rays since the rays at the red end of the spectrum, by the absorption of which most heat would be produced, have no effect on the most sensitive photographic surface, whereas the shortest rays at the other end of the spectrum have a vigorous action in producing decomposition. In what manner do short waves act to produce chemical decomposition? If a string is vibrated in front of a properly proportioned resonator, the volume of sound produced will be magnified many times.

In the practical work of transmitting electricity over long lines by means of alternating currents, it was soon found that where a line had been built in such a manner that it was believed that 10,000 or 20,000 volts would not break down the insulation, yet the insulation did break down in a most unaccountable manner, heavy glass insulators being pierced by the disruptive action of the current. A study of the conditions showed that with a long line having the proper capacity, etc., the wave period of the line might correspond either with the fundamental wave period of the dynamo or one of the harmonics, in which case there would be strong resonance effect, and where the wave rebounded at the end of the line the electromotive force would be many times that originally impressed upon it with the result that rupture of the insulation would take place.

Now it seems to the writer that something akin to this must occur when light produces chemical decomposition and that there is a true resonance effect of sufficient power to break down the force of chemical affinity.

The atoms composing the molecules of substances have vibration periods different, perhaps, for every substance; yet in some these will correspond with the vibration periods of the shorter waves of the spectrum. Where such substances are acted upon by light, we may suppose that when the atoms reach the end of their paths and begin to return, they are acted upon by the actinic vibrations of the ether, and this, recurring with each vibration the power required to arrest the motion of the atoms at the ends of their paths is rapidly augmented until finally they pass beyond the limits of stability and, the force of interatomic attraction being overcome, the molecule goes to pieces and chemical decomposition takes place by the action of ether vibrations through the agency of a true resonance effect. This breaking down of the molecule will occur with a smaller resonance the more unstable the substance, that is, the less the chemical affinity of the atoms composing the molecule; or in other words the greater the tendency of some atoms to pass beyond the limits of the controlling attraction of the other atoms composing the molecule and within the limits of attraction of other atoms with which they more readily vibrate in unison. Stability or unstability of molecules probably depends upon the union of atoms having more or less agreement in the times and extent of their vibration, a group of atoms vibrating in approximately the same time and with the same amplitude, probably being much more stable than a group in which the atoms vibrate in very different periods with widely varying amplitudes. With a group in which the paths and periods correspond it is readily seen that the atoms may always remain close together, and thus continually exert upon each other a powerful attraction tending to hold the group together, but if the periods and paths greatly differ beats will occur, and while at one time they will be vibrating close together, after a brief period they will be vibrating at opposite extremities of their paths, and the attractive force will be very weak. At such times a small resonance effect, acting upon either the atoms of long or those of short period, would drive them beyond the range of attraction of the other and produce chemical decomposition.

If the atoms set free by the decomposition do not find other atoms with which they can vibrate more in unison, they may reunite with those from which they were liberated and reform the decomposed substance. As an example it may be noted that silver salts, when not in the presence of organic matter, will not blacken under the influence of light. In the presence of organic substances the atoms set free unite readily with some elements of the organic matter and bring free atoms in a nascent state have in themselves great decomposing power if their affinity for the elements of the organic matter is strong; *i. e.*, if, as they are projected (by resonance effect) beyond the influence of the atoms with which they were previously vibrating, they find themselves close to atoms of other molecules with which they tend to vibrate in unison.

There is probably a considerable range in the lower spectrum where the wave periods are such as to be capable of producing resonance in different substances.

It is not necessary for stability or unstability that the atoms composing a molecule should have either different periods or amplitudes of vibration as these conditions may occur with precisely the same periods and amplitudes for all atoms. This will be readily seen if we consider two atoms together at any point of their paths and vibrating in the same direction, the same distance and in the same time. They are evidently always in a position to exert a maximum attraction upon each other, and the condition is that of extreme stability. If they are together at any point of their paths and are vibrating in opposite directions, the distance apart will soon reach a maximum and the attraction will be a minimum. Such substances are unstable. If the two atoms vibrate in paths inclined to each other at any angle between these limits of 0° and 180° the stability will be greater or less as the angle is small or great. Obviously in the first case resonance will not tend to produce decomposition, yet, as the amplitudes of vibrations of all atoms will be increased, the volume of the substance will be increased or the action of the actinic rays will be to produce expansion of the mass in precisely the same manner as heat acts by increasing the amplitude of vibration and hence the volume of the mass. This can be tested by using an instrument such as Edison's tassimeter and flashing the short rays of the spectrum upon it, care being taken to eliminate the heat rays.

The wave lengths of the different parts of the spectrum can be measured, and by determining what waves are capable of producing actinic resonance in different substances it may be possible to determine the natural vibration periods of various atoms, and ultimately the dimensions of the atoms.

Another thought which came here is the possibility of determining whether all the so-called elements are in reality composed of one primary substance. If it could be shown that ether vibration of the same period produces a maximum resonance effect in all substances. it would be strong evidence that the ultimate atoms composing all substances are the same. As to the other so-called elements they may have molecules composed of primary atoms so grouped that their relations cannot be altered.

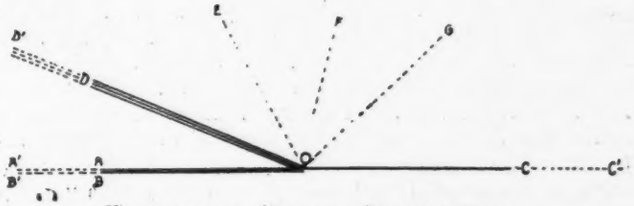
For instance, suppose some molecules were each composed of two primary atoms vibrating in unchanging relation, *i. e.*, suppose they are close together at one point of their path and maintain this distance unchanged in all points of their paths. Manifestly the attraction between them will be a maximum at all times, and this might be so strong that no outside influence could vary the distance apart. Such a combination would evidently constitute an undecomposable substance and appear as an element.

Similarly three atoms might be so combined to form another apparent element and four atoms might form a group of allied apparent elements; for instance, if the four were regularly placed with reference to each other they might constitute a molecule of oxygen, a slightly different arrangement, say two groups of two each, might constitute sulphur and another combination consisting of a group of three and one singly might constitute another element of the same family. The number of atoms and the grouping would undoutedly control the valency of the substance. Various forms of the same substance might be produced by slight possible variations of the groupings of the atoms constituting a molecule. For instance, if four atoms regularly placed with a given distance between them constituted oxygen, then ozone might be produced by a slight increase or decrease in distance apart of the atoms so as to slightly vary the attraction between them and their combined attraction on groups composing other elements. Molecules of decomposable substances would be composed of two or more such stable groups vibrating in paths which made greater or less angles with others, so that the application of a force which would cause them to move further along in their paths would produce a separation and ultimately decomposition, by bringing one or the other of the stable groups within the strong influence of some other group. Two or more stable groups united to form a molecule of decomposable substance could never vibrate parallel to each other and in the same direction, in ther words the angle between their paths could never be zero.

The ideas here expressed may be more clearly represented by means of the accompanying diagram :

Suppose *O* to be the origin towards which all the atoms of a simple molecule, or all the elements of a compound molecule tend to vibrate. If two atoms *O A* and *O B* vibrate always parallel to each other, in the same period, and with the same amplitude, manifestly the attractive force acting between them will remain absolutely unchanged whatever the period or amplitude may be. They will form an absolutely stable molecule and appear as an ultimate element. Similarly the three atoms vibrating in the direction *O D* would form another absolutely stable molecule and appear as another element.

If the molecules vibrating in *O A* and *O D* have a mutual control of each other's motion they will form a



Electricity in Chemical Decomposition.

molecule of a compound substance, but in this case their paths must make with each other an angle *A O D*.

This compound molecule will be in stable equilibium if its constituent molecules do not vibrate beyond certain limits, say those represented by the full lines, but if a resonance effect projected them to the points *A'* and *D'* the distance between them would be increased and the mutually exerted force decreased. If no other substance was present they would return to their former stable state, when the cause producing the resonance was removed, but in the presence of other substances there would be a redistribution of molecules and new compounds be formed. Manifestly if the angle *A O D* was very small a very considerable increase in the amplitude would but slightly increase the distance apart of the molecules, and hence produce but little diminution in the inter-molecular force of attraction. The substance formed, though decomposable by very strong forces, would still be very stable. As the angle increased the stability would become less and less until finally if the group *O D* was vibrating in a direction *O C*, in opposition to *O A*, the stability would be very slight and a very small increase in the amplitude of vibration or the approach of another molecule which vibrates at a smaller angle with either *O A* or *O D* would overcome the force uniting *O A* and *O D* and decomposition would take place.

If the molecules in *O A* and *O D* vibrated in different periods or had different amplitudes or both, then they might vibrate in the same direction and still unite to form compound substances. An ether wave of

a certain period would then affect one more than the other and cause a resonance effect tending to break down the compound molecule. It seems manifest that the natural vibration period of all atoms and molecules closely correspond with the periods of the ether waves near the violet end of the spectrum.

Berkeley, Calif., Sept. 13, '95.

"AS OTHERS SEE US."

What we feared has come to pass. We predicted a month ago that the similarity in name and appearance of The Electrical Journal, (San Francisco) and the Electrical Journal, (Chicago) would prove "a constant source of annoyance." We pointed out to our young contemporaries that a change in name on the part of one of them was desirable or at least that they should make a geographical distinction in their titles.....[but] the Electrical Journal of Chicago manifested an acrimonious determination to retain the name selected by the new San Francisco review. This course is ill-advised and will result in confusion....."Electricity" of London reviews the first number of The Electrical Journal (San Francisco) and says: "The Editors are Dr. Perrine and Mr. G. P. Low; the aims are 'honesty, breadth and helpfulness.' Naturally, the National School of Electricity is regarded favorably." There you are; the organ of the National School of Electricity is mixed up with the new electrical review of the Pacific Slope.....What could be more confusing?—Western Electrician, Chicago.

"The Electrical Journal" is a new journal published in this city. Two numbers have made their appearance, and are very creditable specimens. According to an announcement made in the August number, the name of the publication is to be changed to the The Journal of Electricity. The Journal is edited by F. A. C. Perrine, D. Sc., and George P. Low. It is devoted to the development and exposition of the electrical interests of the Coast. The leading article in the August number is a learned and well-written article on "Steep Gradients on Electric Roads," by Lieutenant W. Stuart-Smith, U. S. N., the well-known electrical engineer of this city.—San Francisco Report.

We note the advent of The Electrical Journal pubited by our friends, Dr. F. A. C. Perrine and George P. Low, and published monthly in San Francisco. The newcomer candidly admits that "our newsy friend, the Electrical Review, is entitled to the distinction of being 'the oldest weekly'," and states as its motto that The Electrical Journal is to be known as "the newest electric cal publication in America." We wish the new venture success. Judging from the excellence of its book reviews, we opine it will pay special attention to this department.—Electrical Review (N. Y.).

The Electrical Journal, a recent publication devoted to electrical interests, came to our desk. We thank Mr. Geo. P. Low, and wish him every success. This paper should receive the support of every underwriter, for it contains matter exceptionally valuable to our professsion. Mr. Low has given able service to this branch of underwriting, and his paper will undoubtedly reflect the ability of which its editor is possessed. The subscription price is one dollar per year.—Rambling Notes, San Francisco.

Another promising publication in magazine form appears for its share of advertising patronage and to aid in disseminating electrical information through the West. The Electrical Journal is published monthly in San Francisco, Cal. It has a good appearance, and its principles, as outlined in the first issue, seem sound.—Scientific Machinist, Cleveland, O.

THE PELTON WATER WHEEL.*

The Pelton water wheel is what may be termed an impulse reaction wheel, the power of which is derived from the pressure afforded by a head of water, supplied by a line of pipe, discharged upon it through a small nozzle, the size of said nozzle being proportioned to the amount and head of water available, and to the power required. The manner of utilizing this pressure is the distinguishing feature of the invention and the secret of ts success.

The plane of the wheel is vertical, turning upon a horizontal axis, the bearings of which are mounted and fixed upon a wooden or metal frame, to which also the nozzle is attached, making the machine, as a whole, self-contained. The bearings are accessible at all times for examination and lubrication, and are easily protected from water and grit. Over the wheel, but not touching it anywhere, is placed a cover for withholding the sling of the water from the wheel, and directing it vertically downward to the tail-race, whence all waste is carried away. It has a number of iron buckets or cups fastened to its periphery, each provided with a wedge dividing the jet (which is applied tangentially) into two parts, one turning to the right, the other to the left, (shown in section in Fig. 3.), the direction of both being almost completely reversed before the water leaves the bucket. To facilitate the escape of the spent water and to utilize all of the head, the stream is usually applied to the lower side of the wheel. The object in this, as in other wheels, is to receive the water without shock, to discharge it without velocity, and to apply the energy thus liberated to turning the wheel in the most efficient manner. †

The extreme simplicity of these wheels renders them strong and durable, not liable to get out of order, and enables them to be run with a minimum of wear. Breakage seldom occurs; the wear is confined to the large shaft bearings and to the vane surfaces over which the water passes. There are no running water joints to preserve, and the nozzle is of the simplest and most efficient form, the cylindrical jet being commonly used. The path of the water in the bucket is short, reducing friction to a minimum. If the water carries abrasive materials, the effect is sometimes seen on the wetted surfaces, but the wear is slight, and never detrimental to efficiency. Then again, all the wheels above two feet in diameter have the buckets bolted on, so that one or more may be easily and quickly replaced without disturbing the installation. This is an advantage which is everywhere appreciated, especially in localities far removed from industrial centers.

The tendency of modern machine practice is to introduce direct connections between the motor and the machine to be driven, thus simplifying the parts, reducing first cost and maintenance, and economizing space. The construction of the Pelton wheel enables this to be

*Being an abstract of the report of the Franklin Institute, through its Committee on Science and the Arts, on the invention of Lester A. Pelton.

†In the Comstock mines at Virginia City, Nevada, are located six wheels, each weighing 220 pounds, developing 125 horse-power each with a stream five-eighth inch diameter, and a head of 1,680 feet. They are forty inches in diameter, are made of phosphor-bronze, and run at a speed of 900 revolutions per minute. In one of the famous Comstock mines at Virginia City, Nevada, is a thirty-six inch Pelton wheel, made of a solid steel disc, with phosphor-bronze buckets securely riveted to the rim. It is located at the Sutro Tunnel level of the California and Cousolidated Virginia shaft, 1,640 feet below the surface. In addition to the head afforded by the depth of the shaft, the pipe is connected to the line of the Gold Hill Water Company, which carries a head of 460 feet, giving the wheel a vertical head of 2,100 feet, equivalent to a pressure of 911 pounds. The water, after passing over the wheel, is carried out through the tunnel, four miles in engtb. The wheel runs at 1,150 revolutions, which gives it a peripheral velocity of 10,804 feet per minute, or about 120 miles per hour. The construction of the wheel amply provides for the centrifugal strain given by the velocity of the water, running without load, when it would attain the enormous speed of 21,608 feet per minute, equal to about 240 miles per hour.

done in all cases where the head, which controls the speed of the buckets, is so related to the rotative speed as to give a wheel of reasonable dimensions. The minimum diameter depends, to a certain extent, upon the quantity of water to be used; if this is large, it may be necessary to use more than one jet on the wheel, or to use two or more wheels on the same shaft, to obtain the required speed. The application of several jets to a wheel does not impair the efficiency when it is carried out according to well-known rules. The cases and foundations are light and simple, there are no expensive penstocks or draft-tubes, no inconvenient means of transmission, no heavy stonework.

Turbines have a distinctive advantage under very low heads, because of the large quantity of water which they can use, but under high pressure the speed becomes excessive or destructive. A free jet or tangential wheel may run to the limit fixed by the strength of the material without injury, there being no wear except in the bearings. The construction of these wheels indicates that a high efficiency may be obtained when running with a full or reduced water supply, and such has been found to be the case. Buckets are designed for a maximum diameter of stream, without reference to the head, but the only objection to a very much smaller stream would be the disproportion of weights and friction surfaces, an ojection which is of very little practical importance. This method is adopted when the quantity of water varies, the minimum stream being often only twenty-five per cent. of the maximum. This can be done with no appreciable loss of efficiency, in strong contrast with the turbine, with its variation of twenty per cent., more or less, under varying gates.

In many cases of use in the mountains there is no need for governing devices; on stamp-mills, for instance, when such are necessary, the method used will depend on the water supply. If a liberal use of water is allowable, a nozzle is used having a ball and socket joint, which permits the stream to be partly or entirely deflected below the buckets. The centrifugal friction governor has been used to a very great extent, the balls acting on a double-geared bevel friction wheel, which opens or closes a butterfly valve.

When a constant speed can be obtained from a source outside of the wheel itself, as from an independent motor, the differential governor is available. This consists of four miter gear wheels in mesh, each forming the side of a square; two opposite gears being loose on the shaft and driven in opposite directions by pullies and belts; the remaining two running free on studs which project from a hub fastened to the same shaft. So long as the pulleys run at the same speed there will be a simple rotation of the gears on their axes; but if one runs faster than the other, the gears on the studs will be revolved bodily around the shaft. This motion, which is very sensitive, is made to open or close a butterfly valve in the service pipe. Safety stops are provided at full open and full shut, to prevent the governor from binding the valve and possibly breaking something. This method is advantageous in electric lighting, where there is a demand for close governing.

Nothing contributes so much to the prosperity of mining and manufacturing as cheap power. Scores of the largest producing and most profitable mines on the Pacifit Coast could not be worked to-day but for this, as most of our heaviest mining operations are based upon handling a large amount of low-grade ore in a most economical way. Another fact indicating the change wrought by the introduction of these wheels is the high price that low-grade mines are commanding when so situated that water power could be availed of; these mines, a few years ago could hardly be given away. Where the power developed by the wheel cannot be applied directly to the machinery to be operated, electrical transmission can cover the intervening space, and so in time these easily established links will connect many of the great industrial establishments with these water powers now by this wheel made economically available.

The remarkable efficiency of the Pelton wheel is a surprise to all who see it in operation for the first time. That a wheel so small as to almost escape observation should be capable of driving the large amount of machinery that is often attached to it is a perpetual wonder even to those long accustomed to its use.

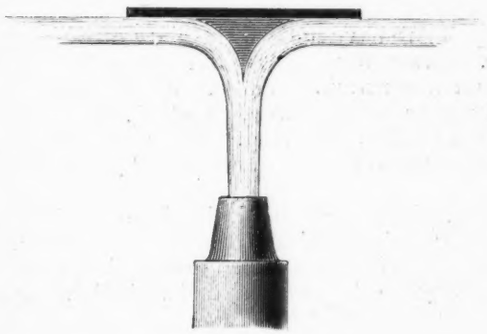


Fig. 1.

Fig. 2.

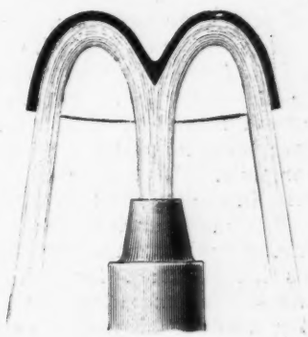


Fig. 3.

FIGURES 1, 2 AND 3.—ILLUSTRATING THE ACTION OF A JET OF WATER STRIKING VARIOUS SURFACES.

These wheels are made in sizes from four inches in diameter, and weighing, with case, twenty pounds, for driving sewing machines, dental apparatus, and the like, to wheels of five, six, eight, ten and in some cases even twenty feet in diameter. Wheels of such large diameter are not for the purpose of increase of power, but to reduce speed so as to make a direct connection to the shafts of the machinery they are to operate, as in the case of pumps, compressors, etc. By applying three, four or five streams to a wheel of ten to fifteen feet in diameter, from 3000 to 5000 horse power can be obtained from a single wheel under a head of 150 feet. This illustrates the extreme flexibility of the system and its application to varying conditions, units of power, speed, etc.

In considering the conditions necessary to a high efficiency in the jet wheel, it will be found that the main conditions are as follows: (1) The jet should enter the bucket without shock and flow over easy curves until its direction is reversed; (2) The surface over which the water passes should be small, to reduce skin friction; (3) The speed of the wheel should be such that the water will leave the bucket without velocity.

Fig. 1 shows the action of a jet of water striking a

flat plate at right angles. It will be seen that the water divides and shows a tendency to form a wedge of still water. This is what may be termed "dead" water, that is, water which has lost its impelling force. In a wheel having this form of vane, there is a tendency to form such a wedge on each vane at every revolution; there can be no smooth flowing of the stream, but a continual turbulence resulting in great loss of energy, and the amount of this will be greater than the loss of part of the energy contained in the water represented by the wedges. It will be seen, also, that the direction of discharge precludes a complete stoppage of the water, the highest theoretical efficiency being fifty per cent., excluding the losses from friction, turbulence etc. In the simple curved buckets shown in Fig. 2 will be found the same condition as to a wedge formation as was shown on the flat plate, the amount of water being even greater. There is, however, a reversal of the stream which allows it to be almost completely checked. This is an important advantage, as may be seen in a comparison of the efficiencies obtained.

Fig. 3 shows a third form, in which the wedge has been made a part of the bucket itself, thus avoiding the loss due to the water-wedge and to turbulence. *Impact* has been reduced to a minimum, and the bucket forms part of an *impulse* wheel. This is the Pelton, which has shown a higher efficiency than any other jet wheel, and which is now replacing the older forms. In wheels having flat radial vanes or buckets, and a tangential application of the stream, the angle of impingement varies as the vanes pass through the jet, but there is at all times an *impact*, resulting in a loss. In contrast with this is the impulse wheel, in which the water enters the vanes or buckets without shock, and is led in the proper path, there being no coercion of the water, but a smooth, regular flow. In the *impact* wheel there is a *blow struck*, while in the *impulse* there is a push.

To make such tests of this wheel as would be convincing and satisfactory, the committee charged with this investigation found to be impracticable. In lieu thereof the committee has found it necessary to rely upon the corroborative results of tests made by men esteemed by the committee as fully competent to do such work.

In the tests of this wheel made by Mr. Ross E. Browne, at the University of California, "the diameter of the wheel was fifteen inches, the width of the bucket 1.5 inch, and the efficiencies shown under a fifty-foot head were as follows:

"With a seven-sixteenth nozzle, 82.6 per cent.; with a three-eighth nozzle, 82.5 per cent. The efficiency was determined under as low a head as eight feet, still showing an efficiency of 73 per cent. It is proper to state that the wheel with which the above tests were made was constructed in the workshop of the University, and did not conform wholly to the manufacturer's standard. The size of the bucket was too small, and did not do full justice to the wheel, owing to the difficulty of shaping the curves accurately. It is claimed that tests with larger wheels have given larger efficiencies, and I have no reason for doubting the claim."

From all that has preceded, the conclusion is reached that the Pelton water wheel possesses all the advantages of simplicity of construction, economy of installation and maintenance, adaptability to extreme heads of water, of transportability, of close and sensitive automatic regulation and of high speeds, which belong to other wheels of its class that have preceded it, but that in point of efficiency it has excelled all others.

The Institute, therefore, deems the Pelton water wheel worthy of the Elliott Cresson Medal, and hereby awards the same to Lester A. Pelton, the inventor.

THE SCIENCE OF GOOD LIGHT.

Many retail stores are dark and gloomy looking, and what a contrast they are to the brilliantly lighted ones, writes Frank T. Green in the Pacific Druggist and Physician. The peculiar part is, continues the writer, that the owners of these same dark stores pay just as heavy bills for light as the former. It is the color of the surroundings that makes the great difference. The world associates dark interiors which lack richness, with gloom, and light surroundings with cheerfulness. The writer asserts there are some colors which are difficult to illuminate, foremost among which are those approaching black. A few years ago it was quite the fashion to have the fittings of stores ebonized and decorated with narrow tracings and lines of gold. A Japanese effect was aimed at, but the bull's-eye of gloom was struck. One of the most trying shades to properly illuminate is terra-cotta. It is difficult, if not impossible, for the color seems to absorb every ray cast upon it. The shadows behind the cornices are heavy ones, and even the high lights emit but a feeble glow, reminding one of reflected firelight. Such a color for a library, accompanied by rich draperies, might be admissible, but in a store it is a most trying one after nightfall. Creams, whites, light grays and pinks are always cheerful, and the shadows warm looking. Besides, with the empire patterns now in vogue, the paler tints harmonize pleasantly.

How many of us have noticed the glare of a white store at night. Every ray gets its full value, for it is reflected without absorption. Those, especially, who have dark fittings in natural wood need light floors, walls and ceilings to offset the effect. The colors should harmonize, however, and the contrasts should not be too severe.

People do not like to enter a black place at night, and in passing stores if one takes the time to observe, the bright effects can often be ascribed to cleanliness and color, and not always to the number of electric lights or gas burners as would at first seem.

ELECTRICITY vs. SOUND IN A FOOTRACE.

That electricity can easily outstrip sound in a foot race, is well known, but as good an illustration of it as was ever furnished, occurred at the time of the last powder explosion at Pinole, observes a California contemporary. At the instant when the great blow-up occurred, the railroad telegraph operator at Pinole, and at Sixteenth st., Oakland, were talking over the wire. The Pinole operator broke the thread of the conversation to rap on the key—"Powder works blown up!" When he received that the Oakland operator had felt no shock, and he thought the explosion must have been a small one, but after waiting about sixty seconds the concussion of the atmosphere came along, and it was violent enough to satisfy him that the blast was no small affair.

The American Institute of Electrical Engineers has issued a neat vest-pocket pamphlet, which has been prepared to meet the demand for information regarding the work of the Institute, and how to join it. It also contains a catalogue of membership, and its mission is for circulation among non-members to whom it will be sent gratuitously upon application to Ralph W Pope, Secretary, 26 Cortlandt street, New York City.

The appointment of Dr. F. A. C. Perrine by the Advisory Council as Local Secretary of the Institute for San Francisco and vicinity has been announced.

The Trade.

In responding to advertisements in this publication, please mention THE JOURNAL OF ELECTRICITY.

AN ENORMOUS ILLUMINATED SIGN.

A feature of the Electric Carnival which excited the wonderment of visitors and the interest of electricians was the enormous sign advertising Ruhstaller's Steam Beer and which was swung across K Street. This sign contained 1010, 16 candle-power lamps; there being 505 on each side. It was fifty-one feet nine inches in length with a maximum height of twelve feet three inches,

the total weight being 2150 pounds, which it is claimed makes it the heaviest flash sign yet constructed. Considerable difficulty was experienced in effecting suitable anchorage to the roofs of the buildings supporting the sign, and the method finally adopted consisted of carrying the anchor lines to other buildings for more rigid support. The wording of the sign, which appears in the accompanying illustration, was so arranged that, by means of carbon break switches operated by an electric motor, the words appeared in their respective colorings consecutively, then flashing on the entire sign.

The contract for the construction, erection and operation of this sign was awarded to Frank Lyman, electrical contractor of 421 J street, Sacramento, whose handiwork was also shown in the construction of the decorative circuits of the State Capitol and surrounding grounds, the May Pole, The Native Sons' Bear, and many mercantile displays.

WIRING EXTRAORDINARY.

The Electric Carnival presented many opportunities for the exercise of the highest art in electro-decorative work, prominent among which were the magnificent floats designed and constructed through the efforts of the Carnival Committee. The electrical effects in the three principal pieces, viz.: "The National," "State" and "Fruit and Flower" floats, which are described elsewhere in this issue, were installed by Messrs. Scott & Black, electrical contractors of 303 J street, Sacramento. This firm is one of the leading wiring concerns of the capital city, and it is safe to state that the bouquets, sprays, wreaths and razzle-dazzles placed on the floats by them formed the daintiest and most fascinating features of the Carnival Parade.

Among the other works installed by Messrs. Scott & Black were the Arches at 7th and J streets, and 4th and K streets, the illuminated sign "Welcome," and of the mercantile displays, those placed about the establishments of Hale Bros. & Co., Hall, Luhrs & Co., Shaw, Ingram, Batcher & Co., Waterhouse & Lester and at the Sutter Club are deserving of special mention because of their artistic workmanship.

A NEW RAILWAY SUPPLY HOUSE.

Messers C. B. Kaufman & Co. have secured storerooms on the ground floor at 525 Mission Street, San Francisco, where they have started in business as a general railway supply house. The firm has in stock, ready for immediate shipment, railway supplies, both steam and electric, of all descriptions, from tie-plates and rails to trolley harps, hangers and insulated wires. Mr. Kaufman has been connected with the well-known electric railway supply firm of Reger & Atwater for some time past, and his many friends will be pleased to learn of his new departure.

A TOWER OF LIGHT.

An attractive feature of the California State Fair at Sacramento was the Tower of Light erected near the center of the pavilion by the Capital Gas Company and which is shown in the accompanying illustration. It was a substantial structure built of gas piping and contained four rows of lights as shown in the engraving, the lower one containing on one side the initials "C. G. Co.," and

on the other sides respectively, were the words "Light," "Heat," and "Power." The two middle tiers were brilliantly illuminated with Wellsbach burners and the upper tier with incandescent electric lamps. The photograph from which the illustration was taken was made by Varney, the leading Sacramento photographer, and presents an excellent specimen of night photography, the light furnished being from the tower alone.

Reports of the Month.

COMMUNICATION.

SAN DIEGO, CAL.—Chas. D. Long has applied for a franchise for a line of telephone poles and wires from Descanso to the Pine Valley Quartz Mill.

GREAT FALLS, MONT.—The Lewistown and Great Falls Telephone Company has been incorporated, with Gold T. Curtis, S. S. Hobson and J. F. Armington as trustees, and $10,000 capital.

SEATTLE, WASH.—The changing-over of the exchanges of the Sunset Telephone and Telegraph Company from multiple switchboards to the express system, which has been in progress since last May, is practically completed.

JACKSON, CAL.—A franchise has been granted the Capital Telephone and Telegraph Company for all streets, alleys, avenues and public grounds and ways of all unincorporated cities, towns and villages within Amador County.

EUREKA, CAL.—The Sunset Telephone and Telegraph Company is building a new pole line for metallic service from this place to Fortuna, Rohnerville and Alton, and the circuits to Arcata and Ferndale will be the next to be made metallic.

SANTA CRUZ, CAL.—The Popular Telephone Company has wired the city for 125 subscribers, and orders have been taken for enough more to make 200 subscribers when the new exchange opens. About 4000 feet of 50-pair lead-covered cable has been run, and Columbia instruments will be used. The installation was made under the supervision of H. N. Snyder.

LITIGATION.

SAN FRANCISCO.—In the suit of Mary L. Keller vs. the Market Street Railway Company, Justice Carroll held that a passenger must demand a transfer at the time of paying fare, otherwise the company is not required to issue same.

SAN FRANCISCO.—On August 23d the Bank of California brought suit in the Superior Court against C. C. Butler, Behrend Joost, Fabian Joost, J. A. Buck and N. Ohlandt to recover $15,000 alleged to be due on a promissory note given by the S. S. Construction Company to the San Mateo and San Francisco Railroad Company. By the latter company it was assigned to the plaintiff.

STOCKTON, CAL.—The Board of Directors of the San Joaquin County Hospital has declined to accept the Doak Gas Engines and the electric lighting plant unless the Doak Company will furnish an indemnity bond to cover any possible damages that may be recovered from the county by the Union Gas Engine Company, which has begun suit against Doak for alleged infringement of its patent.

SAN FRANCISCO, CAL.—The City and County Attorney, in response to a request from the Board of Supervisors, has rendered the opinion that such board does not hold the power to impose a municipal license upon telegraph companies operating interstate lines, but that this is not intended to apply to telegraph companies operating wholly within this State if there are any such doing business in this city.

ILLUMINATION.

HONOLULU, H. I.—The Hawaiian Electric Company, operating arcs, incandescent and power circuits, is supplementing its works by the addition of an ice plant.

CRIPPLE CREEK, COL.—J. W. Bailey has purchased two 40-kilowatt General Electric generators, direct connected to Ideal engines to be used for lighting his gold extraction plant; also an electrolytic dynamo.

WEAVERVILLE, CAL.—There are four electric lighting plants in Trinity County, viz.: At the Brown Bear Mine, Deadwood; La Grange Mine, Oregon Gulch Mountain; Cis Fse Mine, Junction City, and in Weaverville.

SALT LAKE CITY, UTAH.—The city wiring for the Citizens' Electric Light Company is practically completed, and satisfactory progress is being made at the new power house. The four boilers have been placed and the engine is now being erected.

SALT LAKE CITY, UTAH.—Two large generators have been ordered to relieve the machines of the Salt Lake and Ogden Gas and Electric Company, and which will ultimately be used in connection with the Big Cottonwood transmission.

SAN JOSE, CAL.—The Electric Improvement Company expects to have 15 miles of gas mains laid and to have a new gas plant that will furnish gas for $2 or less per thousand feet, erected and in full operation in less than a year.

MARTINEZ, CAL.—Johnson Bros. have submitted a proposition to the Board of Trustees offering to furnish fifty incandescent lights for one year for $1.85 each per month; thirty lights for six months at $2.25 each per month; seven arc lights for a year at $11 per month, or for six months at $12 per month.

CHICO, CAL.—DR. H. H. Clark is negotiating with Surveyor McGavin for the purchase of the latter's water right on Chico creek, with which to operate the new electric light plant.

FLAGSTAFF, ARIZ.—The Flagstaff Electric Light Company, having received its franchise, has begun construction, and expects to furnish lights by October 1st. Its Directors are D. Babbitt, D. M. Riordan, Chas. Canall, T. A. Riordan and F. W. Sisson.

DENVER, COL.—A 50-kilowatt General Electric incandescent dynamo direct connected to an Ideal engine, and one 25-kilowatt General Electric generator, similarly connected, have been bought by the Northern Finance Company for the Felhauser Building.

BERKELEY, CAL.—Now that the new charter has been adopted, the Board of Trustees has more funds on hand for street lighting purposes, and will supplement the present arc lights by 32 candle-power incandescents, about 100 of which will first be placed.

SPOKANE, WASH.—J. B. Fisken has resigned the general managership of the Washington Water Power Company, controlling the Edison Illuminating Company and various street railway systems of this city, and has been appointed superintendent of the Consumers' Light and Power Company.

SAN JOSE, CAL.—The contract for lighting the city by arc lamps for the year beginning October 1st has been awarded to the San Jose Light and Power Company, its bid being $8.90 per lamp per month, against the bid of $8.94 per lamp per month submitted by the Electric Improvement Company.

SAN FRANCISCO, CAL.—The Edison Light and Power Company has reduced the prices of supplies to consumers as follows: Sixteen-candle-power incandescent Edison lamps, from 25 cents to 20 cents each; Edison key-sockets, from 20 cents to 16 cents; Edison keyless sockets, from 18 cents to 13 cents.

SAN FRANCISCO, CAL.—A new 2x400 kilowatt Edison multipolar generator, direct connected to a triple expansion marine type engine, has been installed in Station C of the Edison Light and Power Company, which now contains five 2x200 kilowatt generators and one 2x100 kilowatt generator of the type defined.

PALOUSE, WASH.—The new electric light plant will be located in the roller flour mill, where surplus water-power is available. The projectors have secured an option on the dynamos of the old plant and expect to furnish incandescent light at about fifty per cent. of the rate formerly asked.

PHŒNIX, ARIZ.—The sale of the Gardiner electric light plant to the Phoenix Light and Fuel Company has been consummated, the purchase price being $10,000. The Phœnix power house is to be enlarged and the plants consolidated and increased by the addition of new steam and electric machinery.

SANTA ANA, CAL.—The City Trustees have rejected the bid of C. M. Holmes of the Santa Ana Gas and Electric Company for lighting the city for one year, because the bid was so worded that it was obligatory upon the city to purchase the electric plant for $6,000 if the city refused to renew the contract at its expiration.

RIVERSIDE, CAL.—The City Trustees would like to bring in power for the proposed municipal lighting plant from a water-power eighteen miles distant, but do not see their way clear to do so and furnish the 125 arc lights and the incandescent system desired with the $45,000 that has been voted for the municipal plant.

VICTORA, B. C.—Mr. Hutchinson, superintendent of the new municipal electric light plant, has rendered a report on a 5-hour test of the steam plant in the station, as follows: Coal used, 1450 lbs.; coal per hour used, 290 lbs.; average horse-power developed 158.39; coal used per horse-power per hour, 1.83 lbs.; one boiler was used.

LOS ANGELES, CAL.—The Board of Supervisors has adopted an ordinance imposing a license tax on electric lighting companies as foliows: Plants operating 500 lights or less, $2 per month; those operating 500 lights and less than 1000 lights, $10 per month; those operating 1000 and over, $15 per month. The above includes both arc and incandescent lights.

SAN FRANCISCO, CAL.—A committee of the Union for Practical Progress has addressed a letter to the Board of Supervisors asking that a special election be held to determine whether or not the people should own their own water works, gas works and electric lighting plants, either by buying the existing works from present owners at an appraised valuation or by constructing new works.

FLAGSTAFF, ARIZ.—This place is being wired for electric lights, and the new plant will be installed in the old school house as soon as the engine and dynamo arrive from the East. Incandescent lighting service will be rendered on "flat" rates of $1.10 per month for 11 o'clock lamps and $1.50 per month for lights burning until 1 A. M.

SANTA ANA, CAL.—The Santa Ana Gas and Electric Company proposes to move its plant at once from this city to Olive, where water power is available, provided it receives the contract for lighting the city with forty-arc lamps. It will require about 50,000 feet of wire to "locate" the new lamps, and about 80,000 feet to connect with Olive.

San Francisco, Cal.—The Pacific Coast office of the Westinghouse Electric and Manufacturing Company reports the sale of the following apparatus during the month: 1 60-K. W., A. C. generator with switchboard, apparatus and converters complete; 1 20-light arc plant complete; 1-2½ horse-power, 125 volt generator; 1 60-light, 125-volt generator; Isolated meter orders aggregating 610 lamps.

Forest Grove, Or.—The commissioners appointed to prepare estimates of the cost of buying the electric light plant and putting in wells and pumps to be operated in connection with it, have reported that the total cost of the proposed improvement will be $30,000. The cost of the electric light plant complete is estimated at $12,000. The report was adopted by the Common Council, which at once passed an ordinance calling for an election to vote upon the issuance of city bonds to cover the proposed expenditure.

Spokane, Wash.—The Consumers' Light and Power Company having been awarded a franchise by the Council over the Mayor's veto, has ordered the entire plant for its new electric light and power system, which will cost about $100,000. Contractors are at work blasting out for the foundation of the new power house, which will be situated at the west end on the north side of the island to which the flume under the Washington street bridge will be extended. The monocyclic system is to be used, and it is expected that service will be given before the close of the year.

TRANSPORTATION.

Auburn, Cal.—Messrs. Hartley and Reynolds have secured the franchise previously described for an electric road.

Modesto, Cal.—The Herald calls attention to the advisability of building an electric railway from this city to Coulterville.

Santa Barbara, Cal.—The Santa Barbara Street Railway Company is rebuilding its Garden-street horse-car track for an electric line.

Los Angeles, Cal.—The Kuhrts street line of the Consolidated Company was opened on August 21 for traffic and the running of cars.

Alameda, Cal.—The Alameda Electric Railway Company is having constructed a 2800 gallon sprinkling car, for which salt water will be used.

Portland, Or.—C. E. Smith, Graham Glass and others have secured a franchise for an electric road on First street over the present horse-car line.

Sacramento, Cal.—An application has been filed for a franchise to carry "fruit, vegetables and other freight" over the electric line on V street.

Oroville, Cal.—The project of building an electric road between Oroville and Butte City to Palermo and Biggs is being revived by Messrs. Hatch, Rock and Treat.

Phoenix, Ariz.—Surveying, grading and cross sectioning is being done on the new electric line that will run from First and Washington street to Dennis and Brill's Additions.

Oroville, Cal.—Newspapers are advocating the building of an electric road to run from Oroville to Palermo, thence across the river, passing through the large orchard tracts to Biggs, and then Gridley.

San Bernardino, Cal.—The Pacific Improvement Company (Southern Pacific Company) has bought the Southern California Motor Road, running hence to Riverside. The purchase price was $167,100.

Alameda, Cal.—In order to equalize the wear on car wheels from curves, the Alameda Electric Railroad sends each car on the main loop one way around the circle one day and the reverse during the next day.

Chelan, Wash.—It is stated that J. F. Baker, of the First Chelan Bank, intends to build an electric railway between the foot of Lake Chelan and the Columbia river. The dynamos will be driven by water power.

Castle Rock, Wash.—The Mount St. Helens Railway Company has been incorporated to build an electric railway from here to the mining region of Skamania county. Milton Santee, B. A. Deetz and L. G. Biglow are the promoters.

Redlands, Cal.—Business men are agitating the question of calling an election for voting bonds for the construction of an electric road from Smiley Heights to the Lugonia School, with a branch line up Citrus avenue for two miles.

Redlands, Cal.—A scheme is on foot to consolidate the street-car systems of San Bernardino with that of motor roads leading to the principal resorts of the valley, and convert the whole into electric roads. Power can be cheaply obtained from the Redlands Electric Company, and negotations to that end are now in progress, with strong probabilities of complete success.

Oakland, Cal.—E. P. Vandercook has secured a franchise for an electric road from East Oakland to the county line beyond Livermore, via Haywards and Dublin, and with a spur to Pleasanton. The line will be thirty-three miles in length, which is twelve miles shorter than the present steam route to Livermore, and the maximum grade will be 5 per cent. It is stated that construction will be begun within sixty days.

Oakland, Cal.—Engineers are surveying the route of the proposed Vandercook electric line from Oakland to Livermore, and it is stated that graders and tracklayers will be at work by October 1st. Practically, all rights of way have been secured and the maximum grade will not exceed 6 per cent.

San Diego, Cal.—Geo. B. Kerper, purchaser of the cable road and who proposes to convert it into an electric system, expects to erect various places of amusement at the Pavilion on University Heights. Power will probably be purchased from the San Diego Gas and Electric Light Company.

Concord, Cal.—The construction of an electric railway over the Piedmont hills to Walnut Valley, and thence along the loop connecting with the California and Nevada Railroad, is promised by Gen. J. A. Williamson, of Washington, D. C., who with his associates owns 14,000 acres of land in the Moraga tract, which the proposed road will open up

San Francisco.—J. B. Stetson, Lovell White and others interested in the North Pacific Coast Railway have had surveys and estimates made for the construction of a railroad, to extend from Mill Valley station in Marin County to the summit of Mount Tamalpais, a distance of about four miles. The road will probably circle the mountain.

Los Angeles, Cal.—D. M. McGarry has applied for a franchise for a new street railway to be known as the Los Angeles Belt Railway, which will start at Seventh and Broadway and going east to San Pedro, south to Ninth street, east across the river to Boyle avenue, North to Chicago, north to Brooklyn, west to Bridge, west to Aliso, west to Los Angeles, south to First and San Pedro and west to the starting point.

Los Angeles, Cal.—The Los Angeles Traction Company commenced operations on September 1st by opening its electric road running from the Santa Fe Depot at La Grange Station up Third street to Hill, to Eighth street, to Pearl, to Eleventh, to Georgia Bell, to Sixteenth, to Bush and to the city limits at Hoover street, making a distance of about four and a half miles.

Los Angeles, Cal.—The Board of Directors of the Pasadena and Los Angeles Electric Railway has accepted the property from Contractor Clark, and has paid him for the same an amount in the neighborhood of $400,000, in stocks and bonds of the Company. When its extensions are completed the road and its connections will extend from a junction with the Mt. Lowe road to Santa Monica.

Santa Barbara, Cal.—An eighteen months' franchise has been granted to the Santa Barbara Consolidated Electric Railway Company, and N. F. Ashton states that work will be begun at once on the new electric road. It is stated that as the management was obliged to wait until the preliminaries required by law were complied with under the fifty years' franchise, construction could not be begun for some time to come; hence to hasten the beginning of operations the short-term franchise was granted by the Common Council.

Portland, Or.—S. Z. Mitchell, W. T. Nelson and Fred V. Holman have incorporated the Portland Western Railway Company, to acquire and operate railway lines as follows: the railway formerly owned by the Barnes' Heights & Connell Mountain Railway Company; a railway having its termini at Portland and Hillsboro; a railway beginning at Mount Cavalry cemetery, near Portland, and terminating at Hillsboro; to build railways in any town or city of Oregon; to acquire and operate telegraph and telephone lines and power houses.

Los Angeles, Cal.—The Los Angeles Consolidated Electric Railroad was sold on August 19th to Captain A. M. Payson, manager of the Pacific Rolling Mills, as representative of the holders of $1,500,000 of bonds, or one-half of the face value of the issue. There were two bids. General Manager Fred. W. Wood states that the new owners will spend between $250,000 and $500,000 in improving the system. The entire plant will be operated from one station, which will necessitate the placing of additional boilers, engines and 1000 horse-power direct connected generators. The capacity of the plant will be from 2500 to 3000 horse-power. None of the existing lines will be abandoned, but all cable lines and the Ninth street horse-car lines will be equipped with electric traction, which will do away with the three cable power-houses now operated. The reconstruction of the system has been begun, and will be prosecuted diligently.

San Francisco, Cal.—In changing the Union street cable system, the tracks on Jackson and Washington streets are to be used jointly by the Market street Railway and the Presidio and Ferries Railway (Union street cable line), and the cost of reconstruction will be divided between the two corporations. The Market Street Railway Company, after having equipped the Post street cable line and the Montgomery street horse-car line with the trolley, will operate these lines as a continuous line, reaching the ferry over the Washington and Jackson street roadbed. The Union street cars will take power from the Market street system. The Jackson and Washington street branch will be the first portion of the Union street line to be equipped with electricity, after which will follow the main cable line on Union street to the Presidio, and then to the Harbor View extension, which is at present operated as a steam road.

TRANSMISSION.

REDLANDS, CAL.—The use of electric motors for operating well pumps is becoming very general in this vicinity.

RIVERSIDE, CAL.—Dr. Lyman Gregory has made a verbal offer to furnish water power from the San Jacinto Mountains to operate the proposed municipal electric lighting plant.

SAN BERNARDINO, CAL.—Rev. Boren, Jr., and H. T. Shirley have filed an appropriation of 7000 inches of water from the Santa Ana River for the purpose of developing power for an electric power house.

BUTTE, MONT.—An English syndicate has purchased the Clipper group of mines and will put in an electric power plant at Pony and transmit the power to the mine, where a 200 or 250-stamp mill will be erected.

FRESNO, CAL.—The San Joaquin Electric Power Company has secured a franchise for its pole lines in this city in consideration of supplying to the city, free of charge for ten years, two 2000 candle-power arc lamps.

MESA, ARIZ.—A. J. Chandler, of the Consolidated Canal Company, will have 600 horse-power in electric power ready for delivery in Mesa, shortly. The water power will be obtained from a bluff one and one-half miles from here.

REDDING, CAL.—Geo. P. Himes, acting for Wm. M. Fitzhugh, of San Francisco, has located two water rights at the junction of the Pitt and McCloud Rivers, and states that it is proposed to erect thereat a plant for electrical transmission of power.

NOGALES, ARIZ.—The Boleo Company, operating extensive copper mines at Santa Rosalia, Lower California, is installing an extensive General Electric plant for lighting its works, and running all its machinery. The plant is being forwarded via Guaymas.

PRESCOTT, ARIZ.—Articles of incorporation have been filed by the Arizona Water Storage Company, formed for the purpose of developing water to be used for irrigation, mining, power, etc. Capital stock, $5,000,000. Incorporators, B. Burr, L. Marchant, Wm. E. Hazeltine.

LOS ANGELES, CAL.—Chas. Storey, Engineer of the City Hall, has rendered a report to the Board of Public Works concerning an electric lighting plant for the City Hall. The building should be re-wired, and a 500-light dynamo with additional steam equipment will be necessary.

SALT LAKE CITY, UTAH.—The copper wire for the Big Cottonwood transmission of seventeen miles to this city, and consisting of 214 miles of wire in three sizes, has been made by the John A. Roebling's Sons' works in Trenton. The total weight of this shipment is 218,000 pounds.

VISALIA, CAL.—The surveyors of the Kaweah Electric Power Company have finished the location and cross section of the ditch from the Kaweah River to the site of the proposed plant, but some time will be required to make the necessary maps, diagrams and calculations before ground is broken.

PETREPOLIS, BRAZIL.—The local electric lighting company has increased its plant by the addition of a 120-kilowatt General Electric alternator and Pelton water wheel. The present plant consists of three 120-kilowatt direct connected equipments, hence the total capacity when the new machine has been placed will be 420 kilowatts.

SANTA ANA, CAL.—The action of the Board of Trustees, in calling a special election to vote on a proposition to incur a bonded indebtedness in the sum of $18,000 for the erection of a municipal electric lighting plant, has brought out a proposition from C. M. Holmes offering to sell the entire electric light plant of the Santa Ana Gas and Electric Company for $6,000.

PARK CITY, UTAH.—The drainage water from the Ontario Mine, which has for years been a great burden, has been utilized for an electric lighting plant, and now drives a 3-phase 65-kilowatt generator by means of a Pelton water wheel. The current is conveyed to this city, a distance of three miles, and is used for lighting the company's mills and mine works.

SALT LAKE CITY, UTAH.—The Salt Lake & Ogden Gas and Electric Light Co. proposes to furnish arc lamps for street lighting at the following rates: Fifty to seventy arc lights for two years contract, $11 per light per month; three years, $10.50; for 100 arc lights two years, $10.50; three years, $10; five years, $9.50; for 150 arc lights, two years, $10; three years, $9.50; five years, $9.

SANTA ROSA, CAL.—Local capitalists are considering a transmission project by which electric power will be delivered here from a canyon forty feet higher than the Russian River, and which is situated near Healdsburg. The plant, it is estimated, will generate from 2000 to 5000 horsepower, and it is expected that with additional turbines and canals running out of the initial dam at least 8000 horse-power can be derived.

FRESNO, CAL.—Between 150 and 200 men are at work for the San Joaquin Electric Company on the North Fork. The Canal will be completed by October 1st, and the flumes are about finished. The reservoir will probably be finished by October 15th, and work on the pole line will be begun as soon as the poles arrive from Mendocino County. J. S. Eastwood, chief engineer of the company, states that the plant will be in operation earlier than February.

SANTA CRUZ, CAL.—It is announced that Fred. W. Swanton, manager of the Santa Cruz Electric Light and Power Company, has made terms with Henry Cowell for the purchase of his water rights on the San Lorenzo River, and that an electric power transmission will be placed, if sufficient co-operation from the citizens can be secured. Measurements taken show that 400 horse-power is available during August, and for six months in the year the water-power of the river is equal to 1000 horse-power. The length of transmission is three and one-half miles.

NEVADA CITY, CAL.—One hundred men are at work on the flume of the Nevada County Electric Power Company, and are placing therein from 25,000 to 20,000 feet of lumber per day. All poles and cross arms are on the ground, and, with the line, will be erected at once The generator has been shipped from Pittsfield, Mass., by the Stanley Electric Manufacturing Company, and, without doubt, the plant will be finished as previously announced. The pole line will run from the power house to Sargent's ranch, thence to W. G. Richards' ranch, and from there to the Deer Creek mines, thence to Town Talk and on to Grass Valley. A branch will be run up Deer Creek to supply other mines in that locality.

FRESNO, CAL.—The reservoir for the San Joaquin Electric Power Company will consist of a natural basin covering eight acres, so conditioned as to necessitate the building of a dam on one side only, which can easily be done by throwing up an embankment twenty-three feet high and ninety feet wide at the base, and twelve feet in width at the top. The reservoir thus formed will contain 28,000,000 gallons, and will be at an elevation of 1410 feet above the power house. Three General Electric three-phase generators of 340 kilowatts each, and each being direct connected to a Pelton water wheel, will be used, and on each shaft is to be placed a 6000-pound fly wheel to act as an auxilliary for the governor, which is to be of the Pelton differential type. The dynamos will deliver current at 700 volts, which will be transformed up to 11,000 volts, and transmitted to Fresno, thirty-four miles distant, with a loss of ten per cent. Six No. 3 B. & S. bare copper wires will be used, supported by forty-foot redwood poles, 12x12 at the base, and 6x6 at the top, standard double petticoat porcelain insulators being used. The sub-station will be located adjoining the Sperry Flouring Mills in Fresno. The entire plant, which includes seven miles of ditching and considerable flume work, will cost not to exceed $200,000, and it is claimed will be in operation by February 1st, 1896.

MISCELLANEOUS.

LOS ANGELES, CAL.—The new City Jail, soon to be erected, will contain quarters to be used as the operating room for the Police Patrol system.

MARE ISLAND, CAL.—The Boudreaux dynamo brush, or its equivalent, is considered as the standard in specifications for supplies issued by the Navy Department at this place.

SAN JOSE, CAL.—Bids for an electric elevator proposed to be placed in the City Hall were received from the Crane Elevator Company of Chicago, and the Cahill & Hall Elevator Company of San Francisco, the figures being $27,000 and $29,090, respectively.

OAKLAND, CAL.—Charles F. McDermott, residing at Eighth and Center streets, is perfecting an electric submarine torpedo, the invention of Dr. Gross of Chicago, and which is claimed to be actuated and exploded by electrical means. A public exhibition is promised soon.

PASADENA, CAL.—Articles of incorporation of the California Light and Fuel Company have been filed. Its object is to acquire, construct, operate, sell and otherwise dispose of gas works, gas, electric lights, fuel and power works, etc., and to acquire and dispose of water. Principal place of business, Los Angeles. Directors: T. S. C. Lowe, J. M. C. Marble, L. P. Lowe, W. G. Cochran and H. C. Brown. Capital stock, $300,000.

SEATTLE, WASH.—Arrangements have been entered into between the various electric companies whereby three-fifths of the poles on the principal streets will be taken down and removed, and only the 60-foot poles of the Union Illuminating Company and the 80-foot poles of the Sunset Telephone and Telegraph Company will be allowed to remain.

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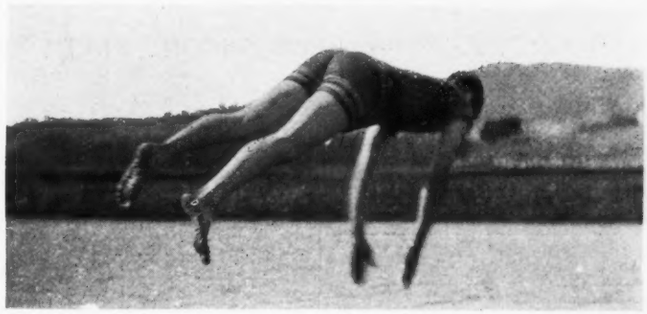

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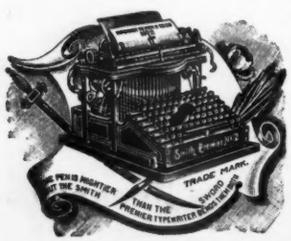

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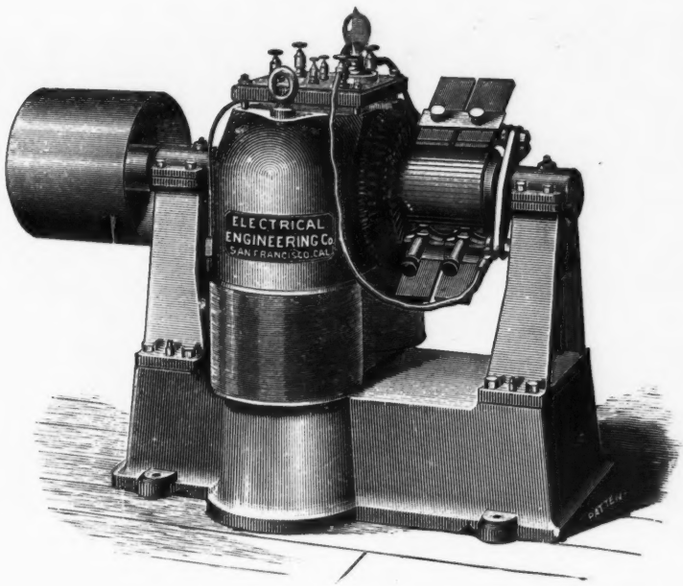

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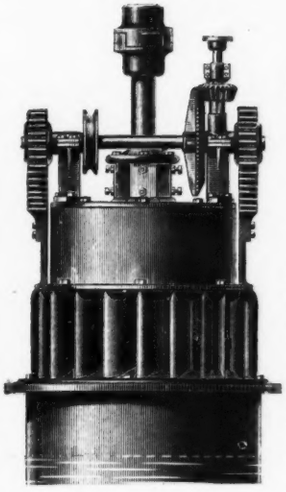

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